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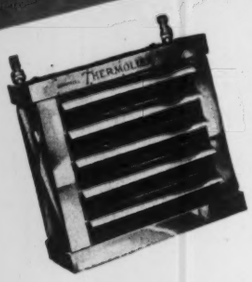

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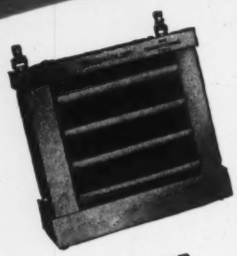

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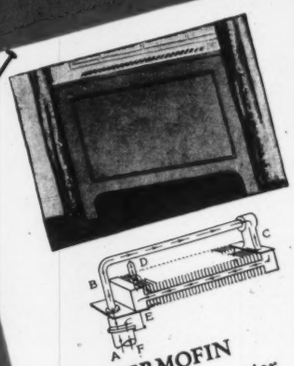

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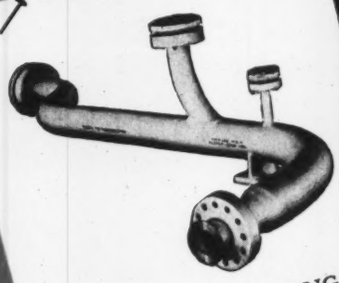

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GRINNELL

WHENEVER PIPING IS INVOLVED

THE EDITOR'S PAGE • January, 1937

■ **Management of the company** looks forward with optimism, according to the annual statement of York Ice Machinery Corp., released by William S. Shipley, president, last month. Orders booked during the year exceeded the previous year by almost 14 per cent, and orders booked during October and November of the new fiscal year exceeded those of the same period of the previous year by more than 75 per cent, a fact which is notable because no large or outstanding orders are included. . . . There is every indication that the momentum of the recovery urge demonstrated in 1936 will carry further improvement for the year 1937, according to F. A. Merrick, president of Westinghouse Electric & Mfg. Co., in his New Year's statement. . . . Marked broadening of the applications of air conditioning, resulting in much wider markets, and collection of data showing in facts and figures the effect of air conditioning on commercial establishments, were two outstanding achievements of 1936, according to J. J. Donovan, manager of General Electric's air conditioning department. Mr. Donovan foresees a good year in 1937, the normal increase in the air conditioning business to be aided by general improved business conditions and the willingness of many industrialists to invest in plant equipment. . . . A sharp upturn in the sales curve of air conditioning equipment for 1937 is predicted by S. F. Myers, manager of air conditioning sales, Westinghouse Electric & Mfg. Co. . . . Col. A. C. Downey, newly appointed president of Airtemp, Inc., air conditioning subsidiary of Chrysler Corp., said at a recent banquet when the company played host to more than 200 direct dealers and distributors of its products, that he believed the day is not far away when the air conditioning industry will be second in size only to the automobile industry in this country. . . . Output of the electric light and power industry during mid-summer of 1936 ran some 18 per cent above the corresponding period of 1935, although these percentages were not maintained during the last quarter because of the sharp rise in industrial output in the corresponding period in 1935, according to C. W. Kellogg, president of the Edison Electric Institute, in his year-end review. Most important central station engineering development of the past few years, according to Mr. Kellogg, was the super-imposed turbine, consisting of a high pressure boiler (about 1,200 lb) operating a turbine at about that pressure, the latter exhausting direct into the steam mains of the existing station.

■ **Long contemplated plans** for establishing a fund and foundation to incorporate study and research for the benefit of the arc welding industry were completed last month by the Lincoln Electric Co. The new fund has been named "The James F. Lincoln Arc Welding Foundation." Dr. E. E. Dreese, chairman of the department of electrical engineering at Ohio State University, will be responsible for principal direction of the foundation's work. . . . The general upturn of business as reflected in the increased activity of the building trades has again made it necessary for the Trane Co. to increase manufacturing facilities. The contract has been let for a new building twice as large as that built last spring; the size and capacity were determined by the company's officials' belief that 1937 business will exceed by 50 per cent that of 1936. . . . Construction of a modern factory and office building for the Penn Electric Switch Co. is nearing completion at Goshen, Ind., where headquarters will be established about February 1; the Austin Co. designed and is erecting the buildings. . . . The office building, 40 by 112 ft, is to be air conditioned, and the entire factory is to be cooled in summer by fan units through which water at 53 F will circulate. This water is taken from the city's new water supply system, and will circulate through the same overhead unit heaters to be employed for heating during winter.

■ **Five years from today** people won't stay in a hotel that is not air conditioned, predicted G. S. Salley, district vice-president of the National Hotel Greeters, according to the "Business Conditioner," official publication of the Air Conditioning Bureau of Omaha. "A first class hotel without air conditioning will become third class," said Mr. Salley. . . . The "Air Conditioning News," bulletin of the Philadelphia Electric Co., reports that air conditioning of a North Philadelphia theater was responsible for an increase in its business of approximately 30 per cent last summer. The installation comprises a 75 hp compressor, one 10 hp and one 15 hp fan.

■ **Lack of standardization** of the dimensions of welding fittings causes users much difficulty, according to the prime movers committee of the Edison Electric Institute, and the committee has, therefore, asked the American Standards Association to consider standardization of these fittings under A. S. A. procedure, says "Industrial Standardization," the A. S. A.'s monthly publication. A typical case of the lack of dimensional uniformity, the committee states, is illustrated by the 4 by 3 in. concentric welding reducer which is offered in four different lengths. . . . Arthur McCutchan's articles on the use of American Standard Pipe Thickness Schedules, published in the October and November, 1936, issues of HEATING, PIPING AND AIR CONDITIONING have been abstracted in "Industrial Standardization"; the original articles included complete tables of the dimensional properties of pipe for Schedules 10, 20, 30, 40, 60, 80, 100, 120, 140 and 160 pipe, compiled from the A. S. A. Standards B36.10-1935 and B31.1-1935. . . . Dana D. Barnum, president of the Consolidated Gas Co., Boston, was re-elected president of the American Standards Association at its annual meeting last month, and Edmund A. Prentis of Spencer, White and Prentis, Inc., was re-elected vice-president. New chairman of the association's standards council is F. M. Farmer, vice-president of the Electrical Testing Laboratories, New York, and C. E. Pettibone, vice-president of the American Mutual Liability Insurance Co., Boston, was named vice-chairman.

■ **39,822 registered attendance** at the Twelfth National Exposition of Power and Mechanical Engineering at the Grand Central Palace in New York City last month. All of the 570 exhibit spaces were taken. Regarded as a barometer of the capital goods industries, the success of the show reflected the recovery that has been achieved. . . . The 1937 Great Lakes Exposition will re-open May 29 on Cleveland's 150 acre downtown lake front exhibit grounds. It is planned to dramatize on a broader scope than was permitted by the brief organization period last year the progress of factory, farm, mine and laboratory. . . . 2,900 tons of steel and iron pipe and 4,500 tons of tile pipe are among the materials that will be required for construction of New York's World Fair of 1939, according to Grover Whalen, president of the Fair Corp. The construction program is expected to get fully under way after grading of the site next spring.

■ **The largest** air conditioning installation in Pittsburgh is Gimbel Bros. department store, according to G. A. Wed-

(*Continued on page* 188, *back section*)

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*Willis H. Carrier, in 1911 disclosed the Carrier Law of Air Conditioning to the American Society of Mechanical Engineers, thereby inventing air conditioning, and making modern refrigeration possible.

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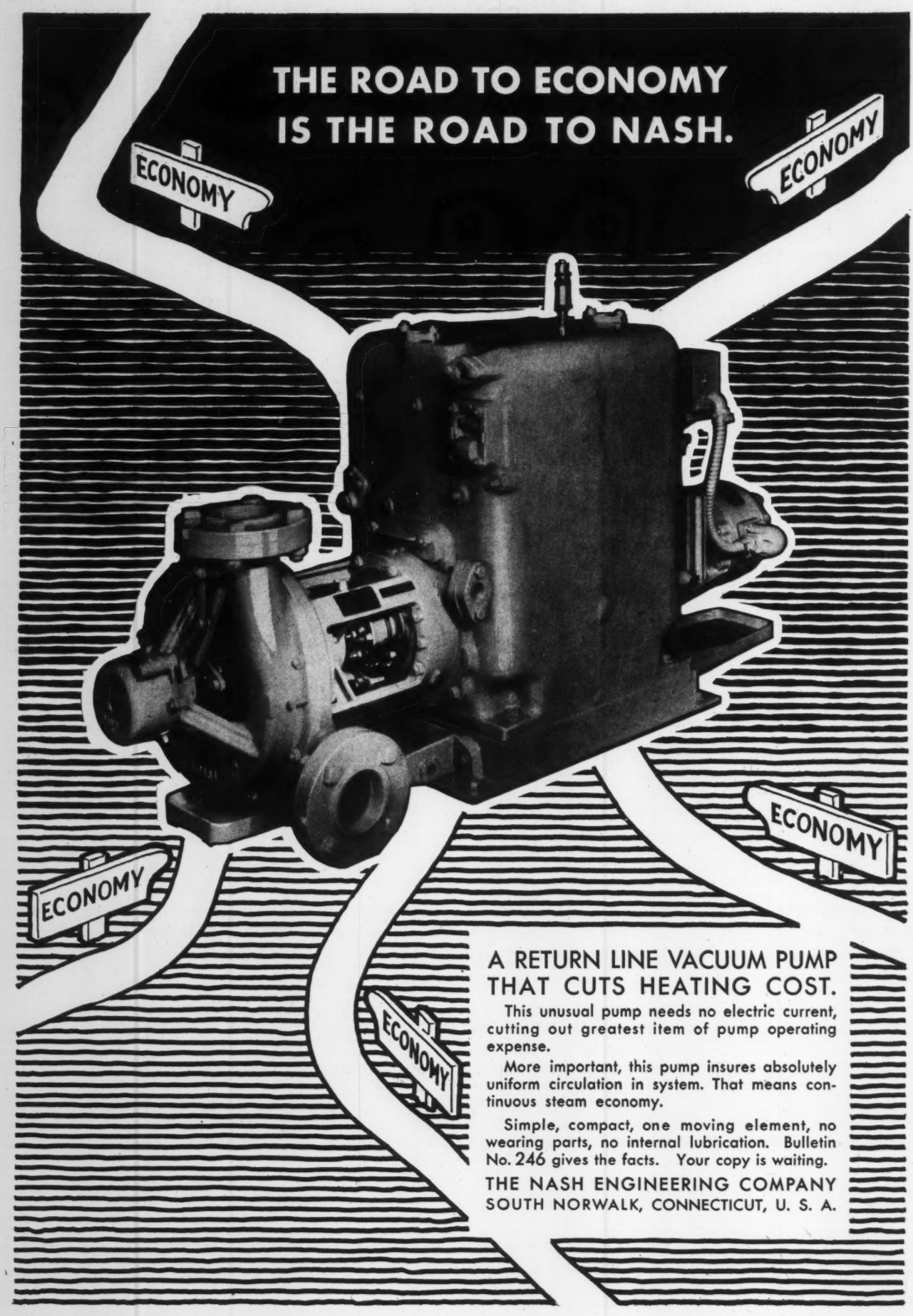
THE ROAD TO ECONOMY IS THE ROAD TO NASH.



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This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

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SOUTH NORWALK, CONNECTICUT, U. S. A.

Heating · Piping
and Air Conditioning

Vol. 9, No. 1 • *January, 1937*

What of the Future in Air Conditioning?

By Walter L. Fleisher*

> **Whoever wishes to pursue properly the science of medicine must proceed thus: First, he ought to consider what effects each season of the year can produce; for the seasons are not all alike, but differ widely both in themselves and at their changes. The next point is the hot winds and the cold, especially those that are universal, but also those that are peculiar to each particular region. . . . For knowing the changes of the seasons, and the risings and settings of the stars, he will have full knowledge of each particular case, will succeed best in securing health, and will achieve the greatest triumphs in the practice of his art.—HIPPOCRATES[1]**

Thus spoke Hippocrates—a member of the guild of the Asclepians, ordinarily associated with the serpent symbol of the medical cult in the ancient world. But according to the accredited derivation, Asclepius is connected with the healing arts through Apollo, the air god, who was definitely associated with the atmosphere.

I have set my picture of air conditioning among the ancients, for if I am to fly into the future it is well to start with beginnings. Also, it is appropriate to introduce my remarks with a quotation from the great physician who was the founder of the school of medicine and who devoted most of his life to the investigation of the effect of weather on the development and health of human beings, for in the future I see the greatest possibilities for air conditioning in the field of health and comfort.

I am going to have to be very careful in my predictions of the future, because in my readings and searches among the ancients I find an enormous amount of material that is too near our present conceptions of air conditioning and too near my ideas of future air conditioning, to be idly passed over. I was going to predict radiant heating or radiant cooling, only to find the excavations of Rome, Pompeii, Herculaneum, Fiesole and other Roman remains definitely indicating the knowledge and use of systems in many ways better than those we are using now.

I have always been interested in evaporative cooling—the reduction of the dry bulb temperature by using the sensible heat in a mixture of air and water vapor to evaporate more water and thus reduce the sensible temperature. (This, by the way, is my pet idea at the present time for spreading the use of comfort cooling).[2] Looking through the records of past experience, I find in pictures of the Egyptians, depicted on the murals found in recent excavations, this very same idea. There is no doubt that evaporation—and even ice—was used to procure comfort cooling in the Egyptian era. I quote from Neuberger's "Technical Arts and Sciences of the Ancients", page 124[3]—

*Consulting and Advisory Engineer, New York, N. Y. Member of Board of Consulting and Contributing Editors.

[1]This quotation from Hippocrates' "Airs, Waters, Places" was brought to my attention through the very astonishingly interesting volumes of William F. Petersen, M.D., called "The Patient and the Weather," published by Edwards Brothers, Inc., Ann Arbor, Mich.—W. L. F.

[2]In an article written by me called "Evaporative Cooling for Comfort," published in the December, 1936, *Refrigerating Engineering*, I made a statement to the effect that the United States divides itself definitely into zones, some of which are ideal for the use of this method, properly designed, as opposed to generally accepted methods of air conditioning with refrigeration. Shown here is a weather map of the United States. In that section of the country where the design wet bulb does not exceed 70 degrees as shown by this contour map, people can be adequately served with properly designed evaporative cooling equipment.

In this same article, I also indicated summer temperatures in the United States for a number of years, during July and August, a table of which is reproduced here. This will give some general idea as to the maximum conditions that were reached during these years and will indicate how much a person utilizing proper evaporative cooling would have to suffer, if any, from a lack of refrigeration. I also stated that adequate equipment is seldom found in the market to produce results which are essential to this type of conditioning; also, that with the greater demand for more outside air and less recirculation, a means is offered to meet the greater demand for cleaning large volumes of air cheaply and that evaporative cooling presents a logical relationship between imposed conditions and the normal functioning of the human system to changing conditions.—W. L. F.

[3]Published by the Macmillan Co., New York, N. Y.

The author—who has been actively engaged and intimately concerned with the development of air conditioning since its inception in industry and its later application to human comfort—lets his imagination roam free, endeavors to predict what the future may bring in the "fascinating art" he has made his life's work. . . . It seems particularly suitable at this time to pause and give thought to the future, for "scientific" air conditioning is generally considered to have had its twenty-fifth anniversary last month; twenty-five years ago, on December 8, 1911, Willis H. Carrier presented his classic paper on rational psychrometric formulae at the annual meeting of the *American Society of Mechanical Engineers* . . . All may not—probably will not—agree entirely with Mr. Fleisher's ideas, but all will find them thought-provoking.

"The conduction of heat was also used for producing artificial cooling—although in a very peculiar manner. Persons placed cold-blooded animals about themselves, and used cold stones, in order to keep themselves cool. An account of the Egyptian women of the fifth century B. C. tells us that they used these means and also the method involving vaporization in order to make their existence more pleasant; 'they had the couch in their litters covered with a thick layer of green leaves and flowers, on which they stretched themselves out, covered with only a thin linen tunic. The curtains were drawn, and then wet with cold water. In addition, they rolled about their necks and arms two or three live adders, and in each hand they took a quartz sphere, a mineral whose temperature remains constantly below that of the surrounding air'."

What Air Conditioning Is

Probably everyone knows that air conditioning consists of the simultaneous control of temperature, humidity or moisture content, air movement, and air quality. We have, in an admirable article by Willis Carrier on the development of air conditioning during the last 25 years which was published recently,[4] a description of the apparatus employed to produce these various results. These are temperature, produced either by heat, or "cold," produced by refrigeration or some other source, such as well water; second, humidity or moisture content, the basic element of air conditioning which has advanced it to its present position; third, the variable, air movement, only of importance when oriented against moisture content (on this particular phase of air conditioning, I must speak much more particularly not only in connection with our modern air conditioning, but because of its relationship to my ideas of the future of air conditioning); and fourth, quality, which has to do with the cleaning, sterilizing, odor removal, etc.

This leaves nothing in our definition of air conditioning except the word "simultaneous," and this particular adjective is probably more responsible for the necessity for advance in the technology of modern air conditioning than any other part of the definition, because all of the other four variables of air conditioning have been used since the earliest times. But until our thoroughly tech-

[4] Heating, Piping and Air Conditioning, A.S.H.V.E. Journal Section, August, 1936, pp. 447-459.

Midsummer wet bulb temperature data

The wet bulb temperatures shown will be exceeded not more than 5 to 8 per cent of the total hours during June to September, inclusive, of a normal summer.

Seattle
Spokane
Portland
Boise
Salt Lake City
Reno
Winnemucca
Las Vegas
San Francisco
San Jose
Fresno
Tonopah
Santa Barbara
Santa Monica
Los Angeles
San Diego
Phoenix
Yuma
Needles
Flagstaff
Grand Canyon
Hurricane
Durango
Pueblo
Denver
Cheyenne
Scottsbluff
North Platte
Omaha
Sioux City
Minneapolis
Duluth
Grand Forks
Williston
Bismarck
Miles City
Billings
Havre
Glasgow
Kalispell
Helena
Butte
Lewistown
Great Falls
Amarillo
Oklahoma City
Roswell
Abilene
Dallas
Fort Worth
Waco
Austin
San Antonio
Galveston
Corpus Christi
El Paso
Memphis
Little Rock
Shreveport
Vicksburg
New Orleans
Meridian
Montgomery
Jacksonville
Tallahassee
Atlanta
Augusta
Charleston
Wilmington
Norfolk
Richmond
Washington
Baltimore
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Binghamton
Rochester
Buffalo
Niagara Falls
Watertown
Oswego
Utica
Schenectady
Albany
Troy
Plattsburg
Burlington
Montpelier
Concord
Portland
Bangor
Eastport
Halifax
Yarmouth
Sydney
Charlottetown
Moncton
Saint John
Quebec
Montreal
Ottawa
Toronto
Hamilton
London
Windsor
Kingston
Peterborough
Sault Ste. Marie
Port Arthur
Fort William
Winnipeg
Brandon
Regina
Moose Jaw
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Calgary
Edmonton
Prince Albert
Saskatoon
Battleford
Prince George
Vancouver
Victoria
Nelson
Kamloops
Penticton
Prince Rupert
Dawson
Whitehorse
Fort Simpson
Fort Nelson
Fort Smith
Hay River
Aklavik
Fort Resolution
Fort Chipewyan
Fort McMurray
Peace River
Grande Prairie
Fort Vermilion
Fort Liard
Fort Norman
Fort Good Hope
Norman Wells
Coppermine
Cambridge Bay
Baker Lake
Chesterfield
Churchill
Port Nelson
Moosonee
Cochrane
Kapuskasing
Timmins
North Bay
Sudbury
Parry Sound
Muskoka
Orillia
Barrie
Owen Sound
Goderich
Stratford
Woodstock
Brantford
Guelph
Kitchener
Waterloo
Galt
Hamilton
St. Catharines
Welland
Niagara Falls
Port Colborne
Simcoe
Dunnville
Port Dover
Tillsonburg
Ingersoll
Woodstock
Stratford
Goderich
Kincardine
Walkerton
Hanover
Durham
Mount Forest
Arthur
Fergus
Elora
Preston
Paris
Brantford
Simcoe
Port Dover
Tillsonburg
Ingersoll
London
Windsor
Chatham
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Sarnia
Petrolia
Wyoming
Forest
Strathroy
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Preston
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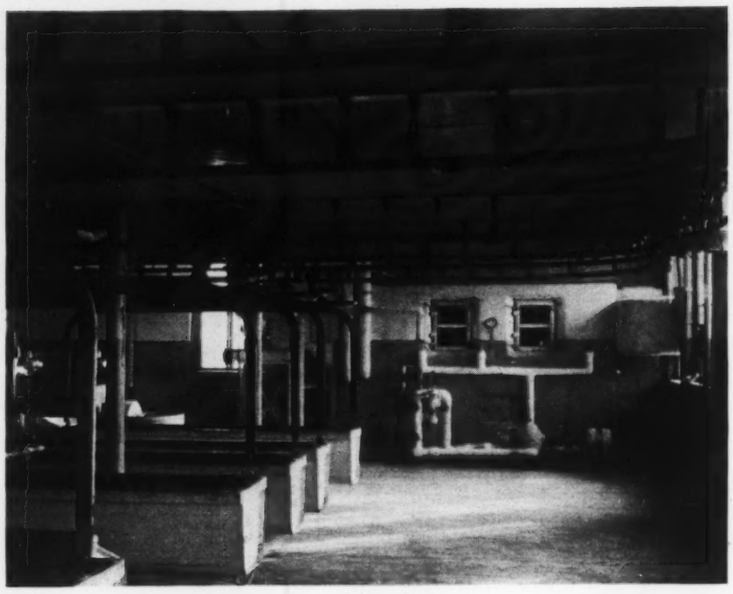
Waterloo
Galt
Hamilton
St. Catharines
Welland
Niagara Falls
Port Colborne
Dunnville
Cayuga
Caledonia
Jarvis
Hagersville
Delhi

SUMMER TEMPERATURES IN THE UNITED STATES

From U.S. Weather Bureau Reports

Note: Data taken during July and August

| CITY | No. of Years Data Taken | Type of Reading | Average Number of Days Per Year That Outside Temperatures (F) Exceed The Following: @ Local Noon | | |



An interesting analogy between the conditions required for the proper "comfort" of dough in bakery air conditioning and proper comfort conditions for human beings is made in the text. The air conditioning equipment for this modern bakery is seen in the background.

utilized with exactly the same resultant condition of the fermenting doughs. This is due to the fact that air movement has a tendency to reduce the film thicknesses of the moisture lying in its path, and consequently, permits of more rapid and effective evaporation. I have known of modern bakeries practically eliminating air movement from a fermentation room and, when maintaining 80 F dry bulb temperature, produced excellent fermentation with relative humidities as low as 50 per cent. This example is cited purely to indicate the importance of the "simultaneous feature" in industrial air conditioning from which, as has been indicated, our modern air conditioning trends and systems have developed.

One might cite the same conditions—or, perhaps, the same inconsistencies—existing in the manufacture of matches or candy. Or one might indicate the necessity for relative humidities different from those required by the actual goods themselves to prevent the occurrence of other conditions having nothing to do with the goods themselves but affecting the processes by which the goods are produced. Consider air conditioning in the printing or lithographing field, where high relative humidities are required to eliminate static electricity, and in the movie industry to eliminate the streaks on motion picture films due to the static sparks produced in low relative humidities when a negative and positive film are withdrawn from contact with each other.

Inconsistencies in Present Practice

Looking into the future of air conditioning, one must always bear in mind the inconsistencies—rather than the consistencies—which exist. In looking forward, we must look on this whole subject from two angles: first, from the material one; (that is, from the viewpoint of the method of production for the results that we desire); and second, from the psychological angle of acceptance. How do we produce commercially at the present time the results that are inherent in air conditioning and how inefficient and inconsistent are the means and the apparatus required to produce these results? As I have stated in my description of the bakery, half the things we do are to overcome part of the things we do because of some other variable. Today, everyone is interested in cooling; so, in most cases we artificially produce a cold medium, and we nearly always produce it by a method that was never particularly designed for the uses to which it is put. Refrigeration is produced by a machine designed to make ice. Any one knows that the temperature of ice is about 32 degrees; that it represents a critical temperature; but the vast majority of the machinery which is being made on the ice-making principle today is designed to produce conditions somewhere around 80 degrees. Now, 80 degrees is a temperature which can be produced many times and in many places without the use of a refrigerating machine at all.

The cooled air is circulated by a fan, usually a multi-blade blower, which is nothing more than an inefficient low pressure air pump which sucks in air at atmospheric pressure and after slightly compressing the air delivers it at desired points at slightly higher pressures and velocities to areas or enclosure where it is intended to produce certain definite results. In cooling systems, this air has its conditions changed by being brought in contact, indirectly, with the refrigerating means which are being produced in another machine, which machine was designed for another purpose than that for which it is being used. This refrigerating means involves two of the factors inherent in the variables of air conditioning: First, it affects the temperature of the air, and second, it may or may not affect its moisture content. If it does affect the moisture content, it probably affects it improperly insofar as the temperature is concerned. Consequently, something else must be done to the air to bring the temperature and moisture content back into simultaneous relationship.

We cannot leave this particular phase of the air conditioning problem without realizing the quality condition of the air. I have mentioned the important functions of quality—dust, dirt, bacteria and odors. Odors can be greatly eliminated by washing. Washing can greatly affect the moisture content of the air, and it may also affect the temperature. Today, a great deal of the cooling effect is produced by indirect contact with a refrigerant, which produces cold surfaces and which has no effect on either dirt or odor elimination and, consequently, must be supplemented by dry filters, in the entering air stream—again a duplication of effort, where one possible simplification has increased the difficulty of producing other elements required in modern air conditioning.

What does "simultaneous" mean to the average per-

son? The only answer I have ever received to this question has been "automatic or thermostatic control." Sensitive elements are the robots of stability or change, affected primarily by temperatures and, occasionally, by relative humidities. Complicated and inefficient methods of producing results can be regulated to produce satisfactory results by an equally complicated system of automatic control. Instead of simplifying the system so that simple automatic controls could produce satisfactory results, complicated controls are used to make complicated results produce simple conditions. (I am making this picture just as complicated and just as inconsistent as I can possibly make it.)

Human Being an Intricate Combustion Machine

In our consideration of the air conditioning of the future, let us think of a human being as a very intricate and involved combustion machine which utilizes the potential energy put into it for the production of heat essential to carrying it forward and wasting most of this energy in the maintenance of equilibrium by eliminating heat in the sensible and latent forms. Here again we have that old problem of the relationship between these two methods of heat elimination, and consequently, diversity of opinion and misunderstanding as to the proper proportions of one to the other. Still, the understanding of the proper relationship is completely essential to the prediction of air conditioning in the future. If all of the waste heat from the human body can just as well be dissipated by radiation, convection or conduction as by evaporation, we have one type of system. If a large percentage of the heat, say, one-third of the total given off by a human being, must be eliminated by evaporation, we have another problem affecting our future air conditioning. If one of our other variables—air movement—will change these proportions or relationships, we have another problem. If the quality of our air is a function of any of these other variables, we have still a further problem.

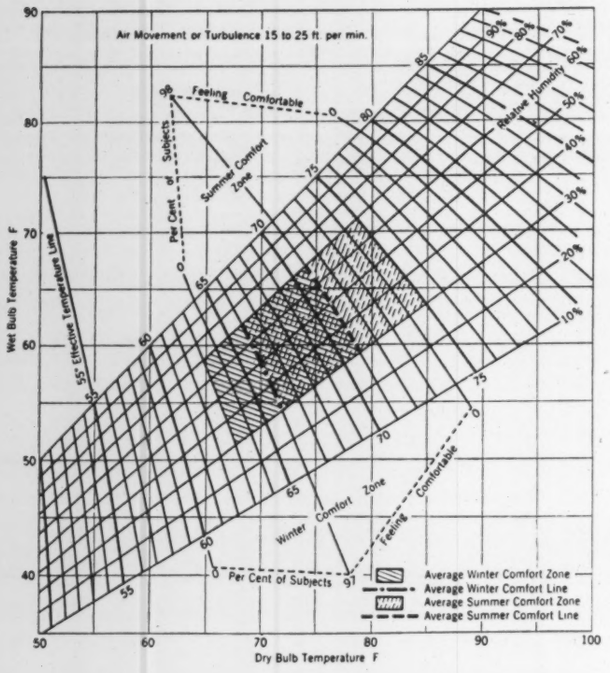
Or suppose we can make the human body function independently of its environment. This, you must admit, would change the entire aspects of future air conditioning in a way that has never before been conceived. Dr. Ransom, of the neurological institute of Northwestern University, in a public announcement only a short time ago, made the statement that the hypothalmius (a tissue or a nerve center, not over ½ in. long and ¼ in. wide, on the inner side of the brain) controls, either electrically or by some unknown chemical method—probably by stimulation of the thyroid or other endocrine gland, or possibly, through the hormones—the ability of animals to protect themselves against heat or cold. One-half of this very small section of the brain controls the function of resistance against both heat and cold, and the other half against cold only. Now, our major difficulty in comfort conditioning today is in satisfying more than half the people, due to the fact that chemically or physiologically, if you will, we are differently constituted, so that our psychological reactions to imposed conditions are different in each one of us. Assume, for a moment, that with some simple electrical contrivance we could change the potential of the hypothalmius in ourselves, so that we reacted differently to imposed conditions at our own will. How simple it would be to predict an air conditioning system for the future, designed for human comfort, without taking into account the idiosyncrasies of the individuals.

In most of our heating systems today, we are producing conditions which we feel are designed primarily to result in comfort conditions for the individual confined in a particular environment. Actually, we are beginning to realize that what we are doing is like the things we do in the bakery, over-emphasizing certain things in order to produce other results which directly affect us. By this, I mean high temperatures in a room, which we think are essential in order to keep us warm are really only as high as they are to heat up the surrounding enclosure. This is to prevent radiation from our bodies at too rapid a rate to the surrounding enclosure. If we insulate and heat our walls to, say, 60 degrees, we may be thoroughly comfortable in rooms of 66 degrees temperature, where, in rooms as warm as 75 degrees, we may still be decidedly uncomfortable, because the walls themselves are at a temperature of only 40 or 50 degrees.

In summer cooling, we have felt that we must have low relative humidities in order to evaporate the moisture or perspiration that appears on the surfaces of our bodies. Consequently, we introduce air into rooms to maintain relative humidities of 30, 40 or 50 per cent. The consequence is that we evaporate moisture at temperatures which do nothing except produce a feeling of chilliness and drafts. Yet, Mr. Houghten, director of the research laboratory of the *American Society of Heating and Ventilating Engineers* (and also experiments that I have run myself) indicates that relative humidities of 90 per cent, with effective temperatures in the neighborhood of 72, 73 and 75 degrees, will evaporate moisture from the body almost as rapidly—and in certain locations, more rapidly—than the lower, draft producing temperatures that I have mentioned. Yet, it must be realized that until we have definitely authenticated these results we are not going to be able to predict the air conditioning of the future with any reliability or certainty.

Inside and Outside Relationship

There is another great uncertainty in connection with comfort conditioning. In the last few years, we have arbitrarily determined that the inside conditions in an enclosure should vary with the outside conditions; in other words, when it is very warm outside, say 95 degrees, that the maintained conditions inside should not be lower than 85 degrees. Still, there seems to be a very well founded opinion that the conditions inside should be maintained in some relationship to the average temperature prevailing over a definite period of time rather than to fluctuations in temperature. This is further borne out by experiments which have indicated that people acclimated to different conditions in different parts of the country react differently to imposed conditions, no matter where they may be during the cooling season. Hippocrates, in his treatise on "Airs, Waters, Places," says:



Comfort or effective temperature chart for air velocities of 15 to 25 fpm (still air)

Note: Both summer and winter comfort zones apply to inhabitants of the United States only. Application of winter zone is further limited to rooms heated by central station systems of the convection type. The zone does not apply to rooms heated by radiant methods. Application of summer comfort zone is limited to homes, offices and the like, where the occupants become fully adapted to the artificial air conditions. The zone does not apply to theaters, department stores, and the like, where the exposure is less than 3 hours.

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"For where the changes of the seasons are most frequent and most sharply contrasted, there you will find the greatest diversity in physique, in character, and in constitution. . . . . For where the land is rich, soft, and well-watered, and the water is very near the surface, so as to be hot in summer and cold in winter, and if the situation be favorable as regards the seasons, there the inhabitants are fleshy, ill-articulated, moist, lazy, and generally cowardly in character. Slackness and sleepiness can be observed in them, and as far as the arts are concerned they are thick-witted, and neither subtle nor sharp. But where the land is bare, waterless, rough, oppressed by winter's storms and burnt by the sun, there you will see men who are hard, lean, well-articulated, well-braced, and hairy; stubborn and independent, in character and in temper, wild rather than tame, of more than average sharpness and intelligence in the arts, and in war of more than average courage."

Perhaps, if Hippocrates' observations are accurate, we do too much or go to too great extremes in order to satisfy the desires of people for something different than their environment provides, which may have nothing but unfavorable results in the development of their characters and the future of the race.

Use of Evaporative Cooling Methods

At this point, I am prepared to start my specific predictions for the future, and I am going to start them by taking our present equipment and indicating my idea of what probably will be done to make the type of equipment which we are now using accord with our understanding of air conditioning and its future requirements. I have spoken lately on evaporative cooling for comfort with the proper type evaporator which will saturate the air at practically the wet bulb and which at the same time will do the essential cleaning and purification of the air inherent in the quality variable of the air conditioning definition. This type of machine depends on the fundamental theory of films in order to produce results. The article[2] in *Refrigerating Engineering* illustrates my ideas in connection with this particular phase of air conditioning for the future. I feel, after much investigation, that this represents an advance in the art of air washing and air cleaning and in air washers and air cleaners, which Willis Carrier, in his paper,[4] "Progress in Air Conditioning in the Last Quarter Century," states has not been advanced in thirty years. This type of machine and its proper use would advance and spread the use of air conditioning for comfort to an infinitely greater extent than could be accomplished with more expensive means, it seems to me. I am not at all sure that the conditions that it would produce would not be much more suitable and propitious than the radical cooling and drying means which are so strongly advocated by many. This method, however, requires an advanced engineering knowledge and as careful calculation—and maybe more so—than the more ordinary methods employed today.

We go through many inconsistencies in order to arrive at results. In this category I should like to mention the use of refrigeration in producing low temperatures, indirectly, to cool air and dehumidify it.

There is very little doubt in my mind that in the future all of these results will be accomplished in one direct acting machine. In other words, the thermodynamics of the air will be used directly to produce all of the results; that is, the air will be compressed and cooled and expanded to produce the necessary conditioned air to provide and maintain the desired conditions in the enclosure to which the air is directed. This machine not only will perform all of these functions, but will also clean and purify the air by means of chemical sterilization.

There is a great tendency today toward the use of chemicals in air conditioning, employing the colloidal method of absorption. This, of course, refers to silica gel and other colloidal solids and the liquid halides, such as calcium chloride, lithium chloride, zinc chloride and the combination with these, in most cases, of secondary means, such as city water interchangers for removing sensible heat, or refrigeration for this purpose, or the propaganda to psychologically produce comfort by high temperatures and low humidities without use of the intermediate stages of this particular process. My feeling is that the future will find the use of this dehydration method utilized in two new ways—not actually new, perhaps, but not yet tried out to any great extent. One

is re-evaporation of low wet bulb air to give cooled air with a higher relative humidity. The second is to produce these results in one step, by regenerating and cooling the liquid dehydrating agent under vacuum, and then utilizing the cooled absorber in direct contact with the air to be treated.

Radiant Energy To Be Employed

The air conditioning of the future is most definitely going to employ radiant energy. Whether this radiant energy will be a function of ionization or whether it will be in the nature of long wave lengths in the infra-red portion of the spectrum is a matter for most intelligent scientific investigation. However, no method of radiation of this type will ever be effective unless it is combined with the proper moisture content or vapor pressure of the atmosphere to affect the specific light wave filtration which is an essential of this type of conditioning. Many of my friends have been of the opinion that my idea of the air conditioning of the future does not include radiation as involved in ionization. My whole contention is that neither ionization nor radiation can be visualized as a solution of any of the problems of future air conditioning without combining them with a variable vapor pressure.

Years ago I suggested as a possibility for future air conditioning the isolation of various conditions to individual persons so that each person could adjust the conditions under which he flourished best for himself; this was in connection with the conditioning of theaters. This has possibilities but little practicability. In this article, I have casually mentioned the control of the hypothalmius. This probably is far fetched and only indicative of science's great advance in the distant future. Nevertheless, it is something to bear in mind when looking forward a hundred years or more. This particular method might orient itself against any of the chemical or biological discoveries which might affect the individual functioning of a particular person.

Air Conditioning for Health

My whole article so far has been concerned with the future of air conditioning from a commercial angle for normal human beings. If I might predict air conditioning for the future in connection with abnormal or pathological cases, I could wax most enthusiastic. In my predictions, I have stressed as being the commercial end of air conditioning, comfort cooling as the major impetus to the spread and development of air conditioning. The future of air conditioning, however, could, if medical research advances its assistance, as I think it will, be oriented toward winter conditioning, where a wave of radiant energy and definite moisture content should lead to much greater happiness, much less nervous strain and better health than our present conditioning is conducive of. If the development of air conditioning of the future does nothing more than confirm the efficacy and curative possibilities of high temperature-high humidity fever therapy treatments for gonorrhoea and syphilis, if its hopes of relieving asthma and arthritis and its promised elimination of colds and nephritis are only carried out to a definite and satisfactory conclusion,I think we will have been well justified in the inefficiencies, the inconsistencies and the illusions through which air conditioning must have struggled to reach the commanding position in society which its fundamental possibilities indicate.

And now, of our homes—insulated, double glassed or without windows, noise-proof, air-proof and vermin-proof—just right for comfort winter, summer, fall and spring—everyone immunized against his own bugs and nobody's else—no one to complain at a card party that he is hot or cold, comfortable or uncomfortable, and nobody daring to move out of the house to chop the wood or bring in the water or able to make a single adjustment against a few of the pranks of nature that he has to face—the whole world regimented under the dictatorship of air conditioning. Well, I don't see that, look as I will into the dim future. For at least ten years I have written against monotony in environment. In certain places in the South Seas and Indian Ocean, the continued sirocco induces insanity. I see for the future of our homes the possibilities of fresh air when we want it, because, as yet, we have not found anything to replace it, and an occasional open window, too. So, I would pin my faith for the future of our homes on the possibility of simply and cheaply being able to do what we want in our homes and not what other people try to impose on us as right. That means outside air when we want it, heated if we want it, cooled if we want it, but always with the right amount of moisture. I think that this implies, as I have said, variations and not too much exquisite softness. Flexibility to adjust ourselves to our environment is just as essential in the future as it has been in the past.

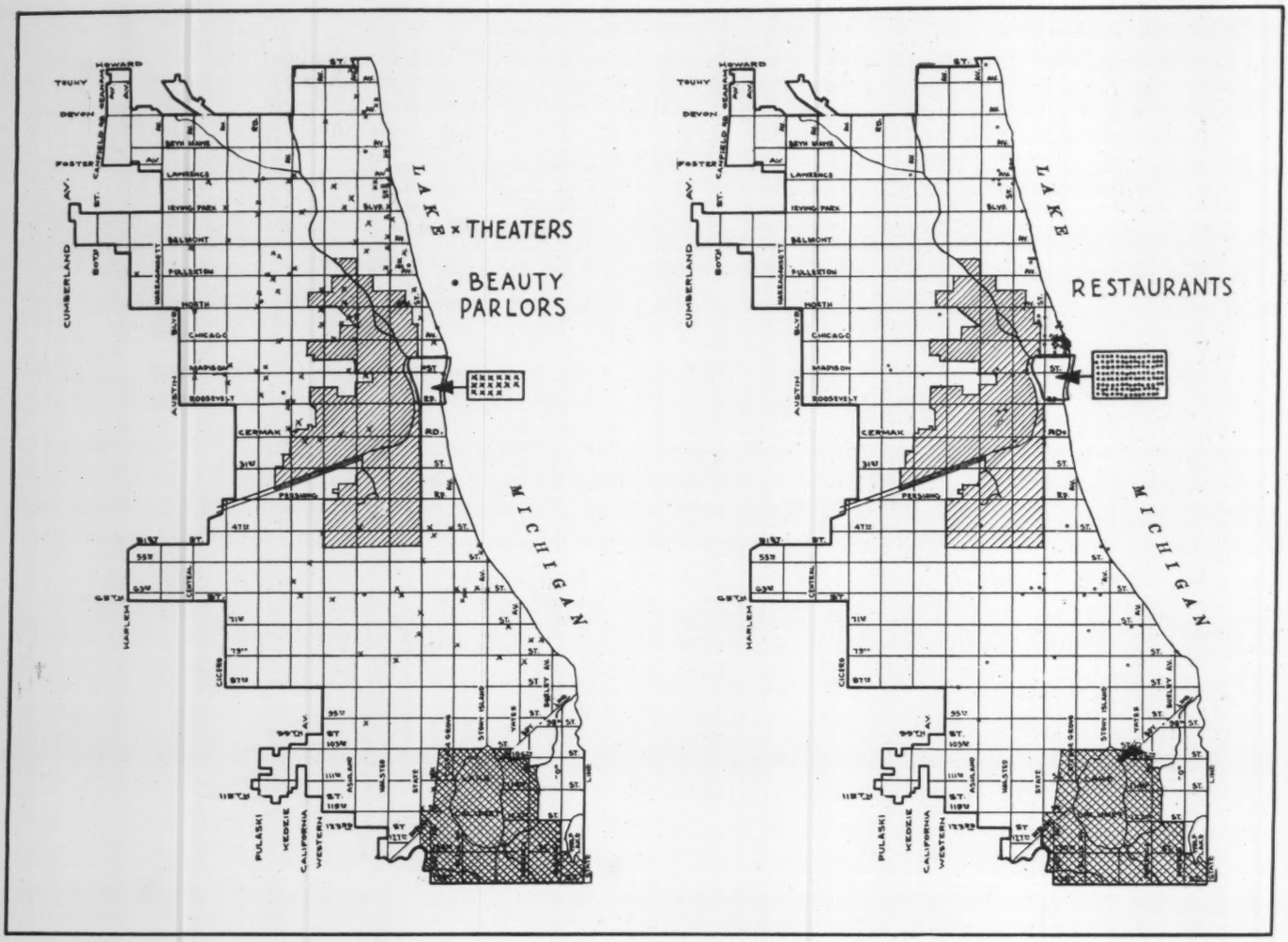
Following are the psychrometric principles which Willis H. Carrier demonstrated in his paper "Rational Psychrometric Formulae" presented twenty-five years ago before the *A. S. M. E.*:

(1) When dry air is saturated adiabatically the temperature is reduced as the absolute humidity is increased, and the decrease of sensible heat is exactly equal to the simultaneous increase in latent heat due to evaporation.

(2) As the moisture content of air is increased adiabatically, the temperature is reduced simultaneously until the vapor pressure corresponds to the temperature, when no further heat metamorphosis is possible. This ultimate temperature may be termed the temperature of adiabatic saturation.

(3) When an insulated body of water is permitted to evaporate freely in the air, it assumes the temperature of adiabatic saturation of that air and is unaffected by convection; *i.e.*, the true wet bulb temperature of air is identical with its temperature of adiabatic saturation. From the above is deduced:

(4) The true wet bulb temperature of the air depends entirely on the total of the sensible and the latent heat in the air and is independent of their relative proportions. In other words, the wet bulb temperature of the air is constant, providing the total heat of the air is constant.



Estimating the Potential Market for Commercial Air Conditioning

By Knight C. Porter* and Wm. P. Rock*

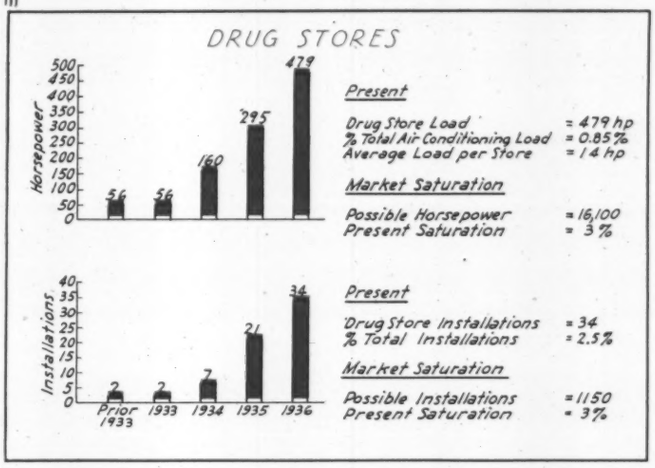
THE air conditioning industry has grown to the extent that an analysis which will indicate its ultimate lifetime accomplishment is of interest. Such an analysis is most important to the electric public utilities as a means of charting future load requirements. Air conditioning load in the summer requires appreciably more electrical capacity than during the balance of the year. Should comfort cooling reach the expected development, it would not be improbable for system load peaks to occur during the summer instead of during winter as at present.

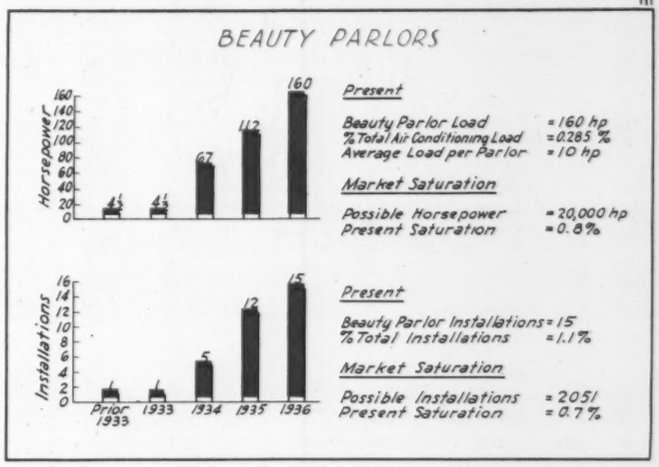
We know that air conditioning will never be installed in *every* commercial, residential, and industrial establishment. Which of these establishments can reasonably be expected to air condition is the question, and the determining factor is of course an economic one. Each class of establishment is affected in greater or lesser degree by the economic desirability for adopting air conditioning. Therefore, an economic survey of a given city should be a definite yardstick of the potentiality of air conditioning expansion.

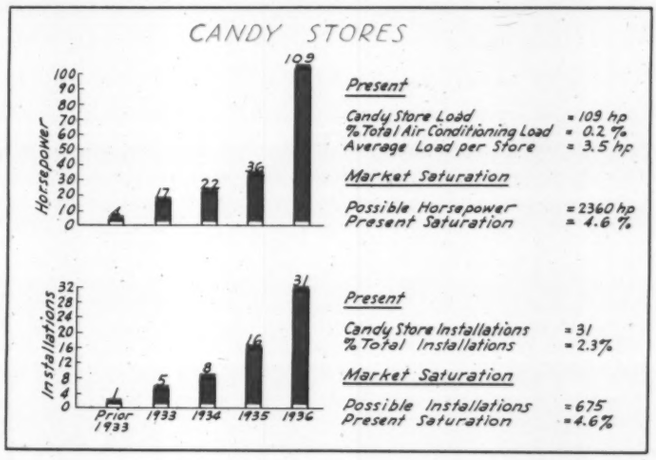
Such a survey has been made of Chicago wherein the city was divided into 48 sections and each section was given an economic rating of A, B, C, D, or E. By locating every air conditioned beauty parlor (for instance) on a map of Chicago, it will show in which area-classifications (A, B, C, D, or E) beauty parlors have air conditioned. Next, by finding out how many beauty parlors there are in each of the 48 sections, and then by

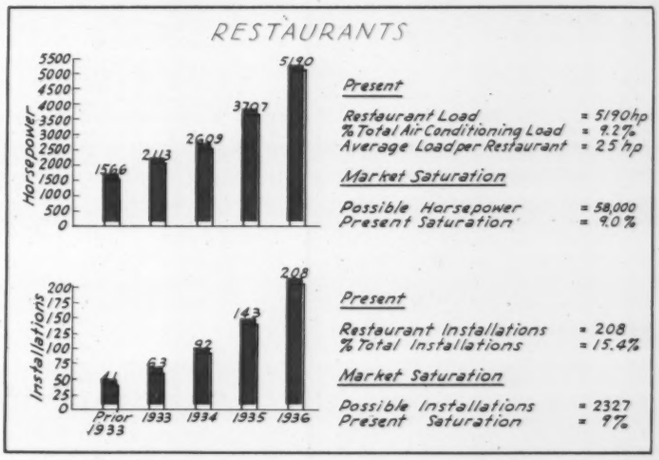
*Air Conditioning Dept., Commonwealth Edison Co., Chicago, Ill.

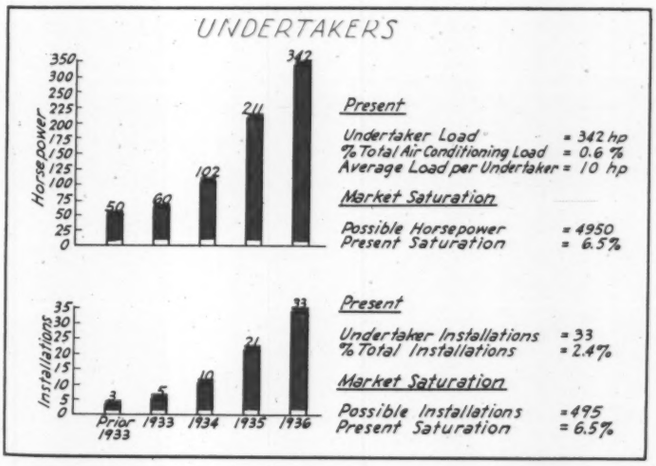
It being reasonable to assume that *every* business establishment in a city will not be air conditioned, the question of how many of the establishments in each classification make up the potential market for air conditioning arises. The method described here bases predictions for the future on past experience; present installations are spotted on a map dividing the city into economic areas and are seen to be in the better, unshaded areas. It is then assumed that all the establishments in the better economic areas —and none of those in the poorer areas—will eventually be air conditioned. Then, from data on present installations it is possible to predict the potential horsepower which eventually will be required for air conditioning . . . Any such method of course cannot be exact; however, it seems to have a fair amount of reason to warrant its acceptance and use.

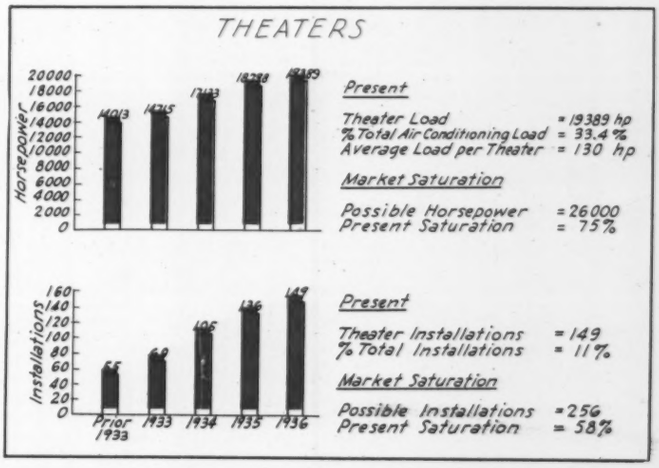


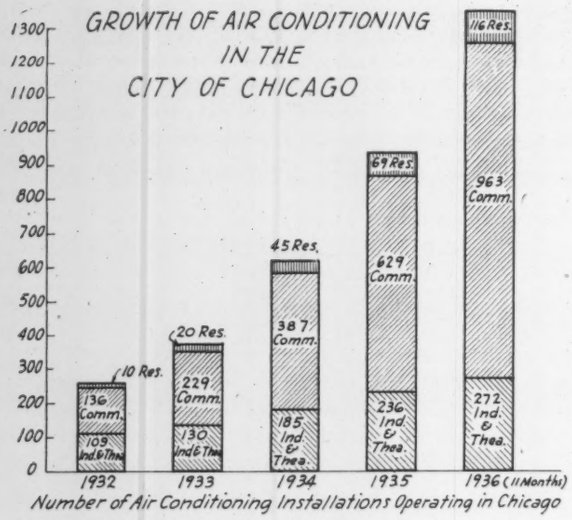












eliminating all beauty parlors which lie in poorest economic districts (shaded areas on maps) which show no present air conditioned parlors, the ultimate number of expected air conditioned parlors may be established.

For instance, in Chicago there are 2632 beauty parlors. The 15 now air conditioned lie in the better economic areas A, B, and C, as expected. The total number of beauty parlors lying in the A, B, and C areas of the total 48 areas is 2051. The average load per beauty parlor at present is 10 hp for refrigeration and fans. Therefore, the ultimate saturation load is estimated at 20,000 hp for the 2051 beauty parlors.

Such a method is not exact, but it seems to have a fair amount of reason to warrant its acceptance. In establishing such a means of estimating, the entire desire was to keep from becoming too deeply involved in detailed variations. The thought was to run down the general course of the river rather than investigate and correct for all the tributaries. As time goes on, corrections can be made as tributary trends appear.

All classes of business cannot be analyzed in quite the same way. For instance, theater air conditioning is found to penetrate into a slightly poorer economic area than beauty parlors—the price and luxury nature of the service being different. Likewise in the restaurant field it was found that many restaurants in poorer districts were air conditioned. This is because many famous restaurants are apt to be located in poorer districts and are patronized by people from higher bracket economic districts. Such irregularities have been taken into consideration after locating present air conditioned business establishments on the maps in order to determine general trends.

The results of some of the main classifications of this analysis for Chicago are shown in the charts, which indicate the growth of each classification.

To some extent air conditioning can be expected to penetrate poorer districts particularly since time will eventually place second hand compressor and auxiliary equipment on the market. Some plan of estimating saturation has been needed not only for the electric utilities but also for air conditioning equipment manufacturers and air conditioning contractors. By considering what will eventually be in terms of what has already been done, it seems that this method is at this time a logical plan of estimating the ultimate growth of air conditioning.

Market Table, Commercial Air Conditioning Installations, Chicago

	No. Installations	% Total Installations	Possible Installations	Horsepower Present	% Total Load	Possible Load	Av. Load per Inst.	Market Saturation
Theaters	149	11.0%	256	19,389	33.4	26,000	130 hp	58%
Restaurants	208	15.4%	2327	5190	9.2	58,000	25 hp	9%
Undertakers	33	2.4%	495	342	0.6	4,950	10 hp	6.5%
Candy Stores	31	2.3%	675	109	0.2	2,360	3.5 hp	4.6%
Drug Stores	34	2.5%	1150	479	0.85	16,100	14 hp	3%
Beauty Parlors	15	1.1%	2051	160	0.28	20,000	10 hp	0.7%

Cold Weather Responsible for Printing Paper Troubles

With the advent of cold weather, printing papers require certain handling precautions not necessary during the summer months, according to the *National Bureau of Standards*. Paper brought into the press room from freight cars, motor trucks or unheated warehouses during cold weather is usually many degrees colder than the room air. When the paper is exposed while still colder than the air, the edges absorb moisture rapidly by condensation from the warm air in contact with it and wavy edges develop very quickly. The results of tests with large piles of paper on skids and with paper in cases indicate that it warms very slowly. Paper 50 F colder than the room air required 96 hr to reach temperature equilibrium with the air. Hence, all paper brought into the press room from colder surroundings should be left sealed in cases, or covered with waterproof wrappers if on skids, for several days before exposing the paper to the room atmosphere. If this precaution is not taken, wavy edges are almost certain to be encountered during the winter season. This is one of the findings of research on lithographic papers being made in cooperation with the *Lithographic Technical Foundation*.

How to Solve Heat Transfer Problems

Part 1—Where One Fluid Is Condensing or Vaporizing

By William Goodman*

Heat transfer problems of practically every class are met in heating, piping and air conditioning work. While research is adding to our knowledge of heat transmission coefficients, there seems to be—in general—lack of knowledge of how to use such data in computing the performance of various types of equipment.... It is to fill the need for this information that these articles have been prepared, their object being to present simple methods for solving such problems, particularly the more troublesome ones dealing with counter-flow.... In Part 1 the classes of heat transfer problems are outlined, and the solution of problems involving condensing or vaporizing fluids is explained in detail. A table compiled by the author which does much to simplify computations is presented

A GREAT deal of work is being done to add to our ever growing need for knowledge of heat transmission coefficients. But — oddly enough —even when transmission coefficients for a particular set of conditions are known there seems, in general, to be some difficulty in manipulating them for computing the performance of various types of heat transfer equipment. It is therefore our purpose to present simple methods for solving various heat transmission problems, particularly the more troublesome ones dealing with counter-flow.

The use of heat transmission factors for determining the area of heat transfer surface required under a particular set of conditions has always been quite easy. For this purpose, the following familiar formula has been used for many years.

$$H = A \times U \times D_m \quad \ldots\ldots [1]$$

H = Total heat transferred per hour
U = Coefficient of heat transmission, Btu per hr per deg temp. diff. per sq ft of surface
A = Area of heat transfer surface, sq ft
D_m = Log mean temperature difference.

While Formula 1 is quite satisfactory for determining the required area of surface under a given set of conditions, it cannot be used for determining the performance of a heat transfer equipment having a certain area. For instance, the final temperature of the air leaving a heating coil of a given area cannot be computed directly by this formula if only the steam temperature and the initial air temperature are known. Another type of problem which cannot be solved by Formula 1 is the determination of the total heat removing capacity of a given condenser when only the initial water temperature and the condensing temperature of the vapor are known. Still a third type of problem which cannot be solved by this formula is that of determining the final temperature of the air leaving a counter-flow heating coil using hot water if only the initial air and water temperatures are known. Yet all of these problems are capable of a direct solution; moreover, the solutions are simple, once familiarity with the method is acquired.

The value of U must be determined experimentally for any particular apparatus. Engineering literature[1], particularly that of the chemical industries, gives a great many methods for estimating the value of U when experimental data are not available. In general, manufacturers can furnish the correct values of U for heat transfer equipment which they manufacture. The values used in the examples in this article are for illustrative purposes only; they should not be used for computations involving actual heat transfer equipment.

Three Main Divisions of Heat Transfer Problems

The computation of heat transfer problems is commonly divided into three main divisions: (1) Condensing or vaporizing. (2) Parallel flow. (3) Counterflow.

In (1) fall all problems in which one fluid is being either vaporized or condensed. During vaporization or condensation, the temperature of any substance will remain constant. It is this fact that makes the computation of such problems easier than those of the other two types. Thus, in a steam blast heater the steam condenses at constant temperature inside the heater, while the air on the outside has its temperature increased as it flows over the hot surface. In a cooling coil the temperature of the vaporizing refrigerant remains constant, while the temperature of the air being cooled falls as it flows over the tubes.

Problems in (2) and (3) include all those where the temperature of both fluids is changing. While the temperature of one fluid is dropping, the temperature of the other is increasing as it receives the heat surrendered by the first. Thus when air is heated by a hot water coil the temperature of the water drops while that of the air increases. In feedwater preheaters used in power plants, the temperature of the flue gas drops as it flows through the preheater, while the temperature of the boiler feedwater rises.

Problems in (2) and (3) differ sharply from those in (1) in

*The Trane Co., LaCrosse, Wis. Copyright, 1937, by William Goodman.

[1] "Heat Transmission," by Wm. H. McAdams, published by McGraw-Hill Book Co., Inc., for example.

that the relative direction of flow of the two fluids must be considered. Thus, in problems in (1) it does not matter whether the air, for example, flows along the tube in a direction parallel to the flow of the steam or whether the air flows along the tube in a direction opposite to that of the steam. The answer will be the same in either case. However, when the temperature of both fluids is changing, the relative directions of the flow of the two fluids affect the performance of the same surface. Thus, in parallel flow both fluids enter the heat transfer surface at the same end and flow along in the same direction parallel to each other to the outlet, Fig. 1. In counterflow, the fluids enter at opposite ends and flow in directions counter to each other, Fig. 2. It is important to remember that the terms "parallel flow" and "counterflow" have meaning only when the temperatures of both fluids are changing as they surrender or gain heat. The terms have no meaning when one of the fluids is condensing or vaporizing, since during such a process the temperature of the fluid whose state is changing remains constant.

In heat transfer problems which arise in actual work, it is usually necessary to find the numerical answer of one of the following five quantities:

Class 1:	A	Area of surface required
Class 2:	H	Total heat transferred from one fluid to the other
Class 3:	t_2 or t_2'	Final temperature of either the warm or cool fluid
Class 4:	t_1 or t_1'	Initial temperature of either the warm or cool fluid
Class 5:	G or G'	Required weight of either the warm or cool fluid

It should be noted that Classes 2 and 3 are intimately related; if either H or the final temperature of one of the fluids is known it is possible to calculate the remaining quantity. Therefore, properly speaking, only four classes should be listed above, since (2) and (3) are to all intents and purposes the same. They are listed separately only for the sake of clarity.

These five classes of problems can occur in problems of any one of the three main divisions—that is, in condensing, parallel flow, or counterflow. An attempt will be made to work sufficient problems in each of the three divisions to give the reader a good idea of how to go about solving problems in any one of the five classes.

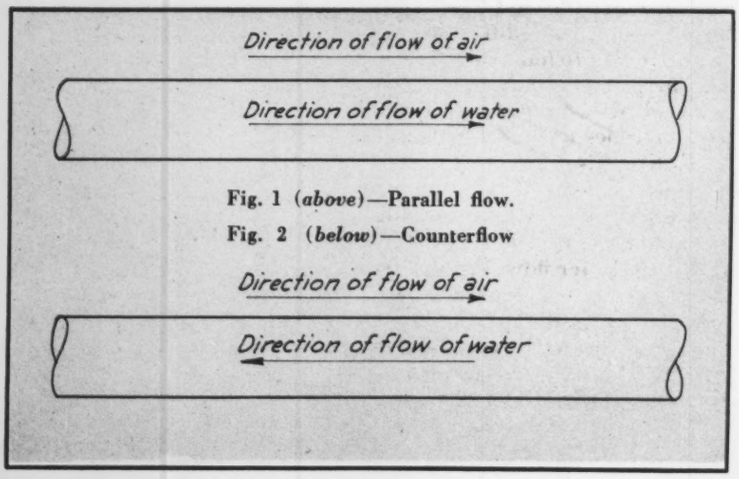


Fig. 1 (*above*)—Parallel flow.

Fig. 2 (*below*)—Counterflow

Table 1—Data Prepared by Author to Facilitate Solving Heat Transfer Problems

$\frac{D_s}{D_L}$	$\frac{D_m}{D_L}$	$\frac{D_s}{D_m}$	M	$\frac{D_s}{D_L}$	$\frac{D_m}{D_L}$	$\frac{D_s}{D_m}$	M
Col. 1	Col. 2	Col. 3	Col. 4	Col. 1	Col. 2	Col. 3	Col. 4
				0.50	0.721	0.693	0.693
0.01	0.215	0.046	4.605	.51	.728	.701	.674
.02	.251	.080	3.912	.52	.734	.708	.654
.03	.277	.109	3.507	.53	.740	.716	.635
.04	.298	.135	3.219	.54	.746	.724	.616
0.05	0.317	0.158	2.996	0.55	0.753	0.731	0.598
.06	.334	.180	2.814	.56	.759	.738	.580
.07	.350	.200	2.660	.57	.765	.745	.562
.08	.364	.219	2.526	.58	.771	.752	.545
.09	.378	.238	2.408	.59	.777	.759	.528
0.10	0.391	0.256	2.303	0.60	0.783	0.767	0.511
.11	.403	.273	2.207	.61	.789	.773	.494
.12	.415	.289	2.120	.62	.795	.780	.478
.13	.427	.305	2.040	.63	.801	.786	.462
.14	.438	.320	1.966	.64	.806	.794	.447
0.15	0.448	0.335	1.898	0.65	0.813	0.800	0.431
.16	.458	.349	1.833	.66	.818	.807	.415
.17	.469	.363	1.772	.67	.823	.814	.401
.18	.478	.377	1.716	.68	.829	.820	.386
.19	.488	.390	1.660	.69	.836	.826	.371
0.20	0.497	0.402	1.609	0.70	0.840	0.833	0.357
.21	.506	.415	1.561	.71	.848	.838	.342
.22	.515	.427	1.514	.72	.852	.845	.329
.23	.524	.439	1.470	.73	.858	.851	.315
.24	.533	.451	1.427	.74	.864	.856	.301
0.25	0.541	0.462	1.386	0.75	0.870	0.862	0.287
.26	.549	.473	1.347	.76	.874	.870	.275
.27	.558	.484	1.309	.77	.879	.876	.262
.28	.566	.495	1.273	.78	.886	.881	.248
.29	.574	.506	1.238	.79	.890	.887	.236
0.30	0.582	0.516	1.204	0.80	0.896	0.893	0.223
.31	.589	.526	1.171	.81	.902	.899	.211
.32	.597	.536	1.139	.82	.907	.904	.198
.33	.604	.546	1.109	.83	.913	.910	.186
.34	.612	.556	1.079	.84	.918	.915	.174
0.35	0.619	0.565	1.050	0.85	0.923	0.921	0.163
.36	.626	.575	1.022	.86	.928	.927	.151
.37	.634	.584	.994	.87	.934	.932	.139
.38	.641	.593	.968	.88	.939	.938	.128
.39	.648	.602	.942	.89	.944	.943	.117
0.40	0.655	0.611	0.916	0.90	0.949	0.948	0.105
.41	.662	.620	.892	.91	.955	.953	.094
.42	.669	.628	.868	.92	.959	.959	.083
.43	.675	.637	.844	.93	.964	.965	.073
.44	.682	.645	.821	.94	.970	.969	.062
0.45	0.689	0.653	0.798	0.95	0.975	0.974	0.051
.46	.695	.662	.777	.96	.979	.980	.041
.47	.702	.670	.755	.97	.986	.984	.030
.48	.709	.677	.734	.98	.991	.989	.020
.49	.715	.686	.713	.99	.995	.995	.010

D_L = large temperature difference, and D_S = small temperature difference used in determining log mean temperature difference, D_m. See text for the various formulas for M.

Condensing or Vaporizing Fluids

Because they are easiest, problems of the first division (that is, those in which one fluid is condensing or vaporizing) will be discussed first. Formula 1 has become firmly entrenched in the engineering world for finding the area of heat transfer surface required to cool or heat a fluid through a temperature range; for this purpose it is eminently satisfactory. In order to facilitate the determination of the log mean temperature difference needed to apply this formula, the values in the first and second columns of Table 1 have been prepared by the author. The values in the first column give the ratio of D_S/D_L where D_S = small temperature difference; D_L = large temperature difference.

Figs. 3 and 4 show how the values of D_S and D_L are determined. They also show the temperature of the fluid whose temperature is changing at any point on the heat transfer surface—in other words, the temperature after the fluid has traversed any given amount of surface. Incidentally, it is well to point out in

connection with these figures that symbols with prime marks always refer to the cool fluid, while symbols without prime marks always refer to the warm fluid.

The second column of Table 1 gives the ratio D_m/D_L. D_m has previously been defined as the log mean temperature difference. Thus, if the ratio of the initial and final temperature differences is known, the log mean temperature can quickly be found by means of Table 1.

Example 1 (log mean temperature): Air is heated from 20 deg to 150 deg by steam at 220 deg. Find the log mean temperature difference.

Solution: (Note—In solving any heat transfer problem, a sketch similar to Fig. 3 is always of help. The various known temperatures should be marked on the sketch at the proper points):

$$D_s = 220 - 150 = 70 \text{ deg}$$
$$D_L = 220 - 20 = 200 \text{ deg}$$

$$\frac{D_s}{D_L} = \frac{70}{200} = 0.35$$

Referring to Col. 1 of Table 1 for a value of 0.35, the value of D_m/D_L in Col. 2 is found to be 0.619.

$$D_m = 0.619 \times D_L = 0.619 \times 200$$
$$= 123.8 \text{ deg mean temp. diff.}$$

Example 2 (Class 1): Take the conditions of Example 1 and find the area of surface required to heat 500 lb per min of air. The value of U is 10 Btu.

Solution:

$$H = 500 \times 60 \times 0.24 \ (150 - 20)$$
$$= 936{,}000 \text{ Btu per hr}$$
$$H = U \times A \times D_m$$
$$A = \frac{H}{U \times D_m} = \frac{936{,}000}{10 \times 123.8}$$
$$= 756 \text{ sq ft required area of heat transfer surface}$$

As has previously been stated, Formula 1 is satisfactory for finding the required area of heat transfer surface but it cannot be used to find the heat which a given amount of surface can transmit if only the initial temperatures of, say, the air and steam are known. For this purpose it is necessary to use the values in the fourth column of Table 1.

When one of the fluids is vaporizing or condensing, the value of M in Col. 4, Table 1 is given by

$$\mathbf{M = \frac{UA}{Gs}} \quad \text{.....[2]}$$

where U and A are as heretofore, and

G = lb per hr of the one fluid whose temperature is changing. (Either G or G' should be used in the above formula, depending upon which fluid is changing in temperature)

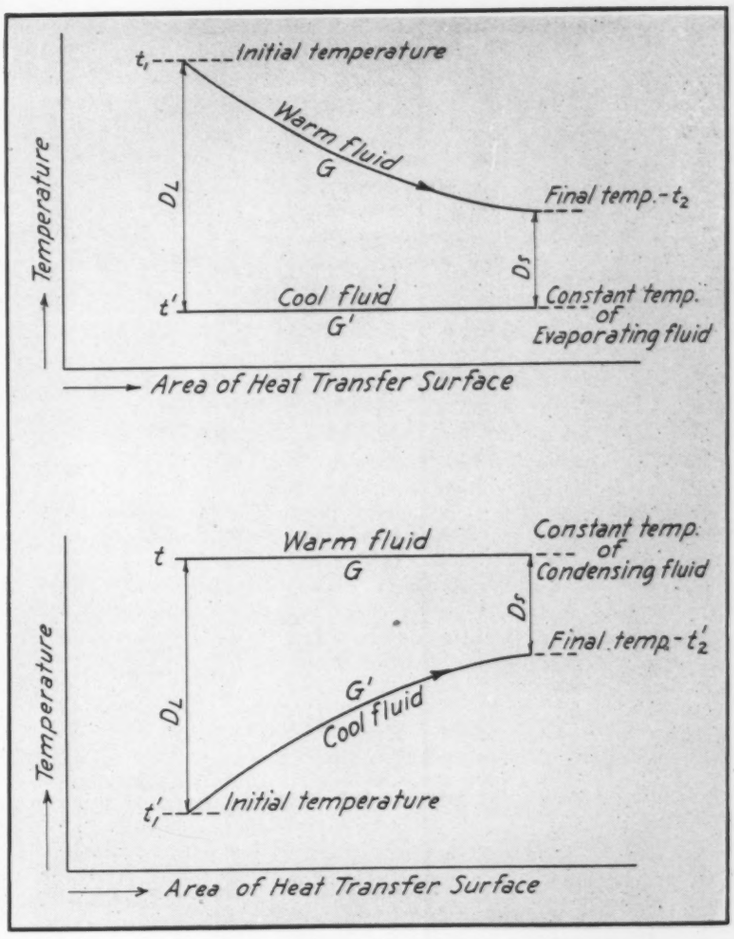


Fig. 3 (*above*) and Fig. 4 (*below*)—Illustrating how the values of D_s and D_L are determined. These curves also show the temperature of the fluid whose temperature is changing at any point on the heat transfer surface. The prime marks refer to the symbols for the cool fluid

s = specific heat of the one fluid whose temperature is changing. (Either s or s' should be used in the above formula, depending upon which fluid is changing in temperature)

If the value of M is known, it is possible, by Table 1, to find the value of the ratio D_s/D_L. With this ratio known, the total heat transferred can be computed. The following examples illustrate the method to be used.

Example 3 (Classes 2 and 3): A steam coil having an area of 150 sq ft is to be used to heat 6,000 cfm of air. The value of U is 13 Btu. The temperature of the condensing steam is 220 deg and the initial temperature of the air is 40 deg. Find the final temperature of the air and the total heat transferred by the coil.

Solution:

$$G's' = 6{,}000 \times \frac{60}{13.3} \times 0.24 = 6{,}510$$

(13.3 cu ft is volume of 1 lb of air at 70 F; 0.24 = specific heat of air)

$$M = \frac{UA}{G's'} = \frac{13 \times 150}{6{,}510} = 0.30$$

Referring to Col. 4 Table 1, for $M = 0.30$, find in Col. 1

$$\frac{D_s}{D_L} = 0.74$$

$$D_L = 220 - 40 = 180 \text{ deg}$$
$$D_s = 180 \times 0.74 = 133 \text{ deg}$$

Referring to Fig. 4, final air temperature

$$t_2' = t_2 - D_s = 220 - 133$$
$$= 87 \text{ deg final air temp.}$$
$$H = G's' (t_2' - t_1')$$
$$\text{Heat removed} = 6{,}510 (87 - 40)$$
$$= 306{,}000 \text{ Btu per hr}$$

Such a problem as the preceding one would be impossible of solution by Formula 1 alone unless time and patience were available for cut-and-try methods. The method of Example 3 can also be used to find the capacity of a given condenser if the only temperatures known are those of the condensing vapor and the water entering the condenser.

Example 4 (Classes 3 and 5): A "Freon" condenser is connected to a compressor having a capacity of 30 tons. Suppose that 230 Btu per min are rejected to the condenser for each ton of refrigerating capacity. The condenser has 260 sq ft of heat transfer surface and is supplied with water at 75 deg. The value of U is 90 Btu. Find the quantity of water needed to keep the condensing temperature down to 104 deg, and also the final temperature of the condensing water.

Solution: First use Formula 1 to find D_m:

$$H = A \times U \times D_m$$

$$\text{Heat rejected to condenser} = 30 \times 230 \times 60$$
$$= 414{,}000 \text{ Btu per hr}$$

$$D_m = \frac{414{,}000}{260 \times 90} = 17.7 \text{ deg}$$

$$D_L = 104 - 75 = 29 \text{ deg}$$

$$\frac{D_m}{D_L} = \frac{17.7}{29} = 0.61$$

Referring to Col. 2, Table 1, for $D_m/D_L = 0.61$, find in Col. 1

$$\frac{D_s}{D_L} = 0.34$$

$$D_s = 0.34 \times 29 = 9.9 \text{ deg}$$

Referring to Fig 4, final temperature of water,

$$t_2' = t_2 - D_s = 104 - 9.9$$
$$= 94.1 \text{ deg final temp. of water}$$

The weight of water required is found as follows,

$$H = G's' (t_2' - t_1')$$
$$414{,}000 = G' \times 1 \times (94.1 - 75)$$
$$G' = \frac{414{,}000}{19.1} = 21{,}700 \text{ lb per hr}$$

or $$\frac{21{,}700}{8.33 \times 60} = 43.4 \text{ gpm of water required}$$

(8.33 lb is weight of 1 gal of water)

Example 5 (Classes 4 and 5): A "Freon" condenser having 135 sq ft of surface is connected to a compressor of 20 tons capacity. The condenser is supplied with 75 gpm of water having an initial temperature of 80 deg. The value of U is 115 Btu. Find the condensing temperature that can be maintained and the final temperature of the water. Figure 230 Btu per min is rejected to the condenser for each ton of refrigerating capacity.

Solution: Heat rejected to condenser

$$H = 20 \times 230 \times 60$$
$$= 276{,}000 \text{ Btu per hr}$$
$$G's' = 75 \times 8.33 \times 60 \times 1$$
$$= 37{,}500 \text{ lb of water per hr}$$
$$276{,}000 = 37{,}500 (t_2' - t_1')$$
$$t_2' - t_1' = \frac{276{,}000}{37{,}500} = 7.4 \text{ deg}$$
$$t_2' = 80 + 7.4$$
$$= 87.4 \text{ deg final water temperature}$$
$$H = A \times U \times D_m$$
$$D_m = \frac{H}{A \times U} = \frac{276{,}000}{135 \times 115} = 17.8 \text{ deg}$$
$$M = \frac{UA}{Gs} = \frac{115 \times 135}{37{,}500} = 0.414$$

Referring to Col. 4, Table 1, for $M = 0.414$, find in Col. 2,

$$\frac{D_m}{D_L} = 0.818$$

$$\frac{17.8}{D_L} = 0.818$$

$$D_L = \frac{17.8}{0.818} = 21.8 \text{ deg}$$

Referring to Fig. 4,

$$t_1 = D_L + t_1' = 21.8 + t_1'$$
$$= 21.8 + 80 = 101.8 \text{ deg condensing temperature which can be maintained.}$$

Example 6 (Classes 2 and 3): A shell and tube water cooler has 550 sq ft of heat transfer surface. 175 gpm of water having an initial temperature of 58 deg is to be cooled by "Freon" which is evaporating at a temperature of 40 deg. The value of U is 125 Btu. Find the final temperature to which the water can be cooled and the refrigerating capacity of the cooler.

Solution:

$$Gs = 175 \times 8.33 \times 60 \times 1$$
$$= 87{,}500 \text{ lb per hr}$$
$$M = \frac{UA}{Gs} = \frac{125 \times 550}{87{,}500} = 0.787$$

Referring to Col. 4, Table 1 for $M = 0.787$, the value of D_s/D_L in Col. 1 is found to be 0.46.

$$D_s = 0.46 \times D_L$$
$$D_L = 58 - 40 = 18 \text{ deg}$$
$$D_s = 0.46 \times 18 = 8.3 \text{ deg}$$

Referring to Fig. 3, final temperature of water,

$$t_2 = D_s + t_1' = 8.3 + 40$$
$$= 48.3 \text{ deg final temp. of water}$$

$$\text{Total heat removed by cooler} = 87{,}500 (58 - 48.2)$$
$$= 857{,}500 \text{ Btu per hr}$$

$$\text{Refrigerating capacity of cooler} = \frac{857{,}500}{12{,}000} = 71.5 \text{ tons.}$$

[To be continued. Further articles of this series will cover solutions of parallel flow and counterflow problems.—EDITOR]

Welded Fabrication of Manifolds and Special Fittings for Piping

By Sabin Crocker*

AN outstanding advantage in the adoption of welded construction for high pressure, high temperature power plant piping lies in the substitution of fabricated parts for the cumbersome cast steel manifolds and other special varieties of flanged fittings. Typical examples of old-style flanged castings in contrast with their welded counterparts are shown in Figs. 1 to 5, inclusive. Not only are the fabricated articles lighter and cheaper to build, but if properly made they are sounder than castings, being devoid of numerous inherent weaknesses which characterize large steel castings of varying metal section.

The procurement of sound castings of the sort shown in Figs. 1 and 2 was in itself no small task both on account of the weight of metal required in one pour and the difficulty with porosity where thick flanges and supporting pads joined relatively thin body sections. In one instance within the writer's knowledge six manifolds were cast in order to obtain one which was acceptable. This particular trouble was due to warpage or shrinkage, and to the drawing apart during cooling of the flanges and integrally cast supporting feet from the main body of the casting.

Fig. 1 shows a large cast steel manifold weighing about eight tons used in the main steam header of the Trenton Channel Power House which was built during the period of 1922 to 1926. The manifold serves as a linkage between boiler and turbine leads and the crossover leading from one end of the plant to the other. The enlarged body with tapered necks leading to the outlet flanges was provided to reduce the pressure loss where steam turned the corner, as it were. The long necks were intended as rather efficient expanding nozzles while the shorter necks were deemed nearly as efficient in the role of contracting nozzles. The integrally cast supporting pad or foot shown at the bottom center of the manifold was regarded as essential at the time although it decidedly complicated the casting problem. In going to welded fabrication these refinements of design, intended to minimize pressure drop and to facilitate support, were discarded in favor of simplicity, the change in method of support being furthered by the lighter weight of welded construction and the ability to weld the requisite supports to the manifold in cases where clamps alone did not suffice (see Fig. 5*c*).

A direct comparison between a cast fitting and its welded equivalent for the identical purpose is perhaps the most striking method of contrast, but unfortunately photographs of the old equipment are not always available and drawings do not accentuate differences to so

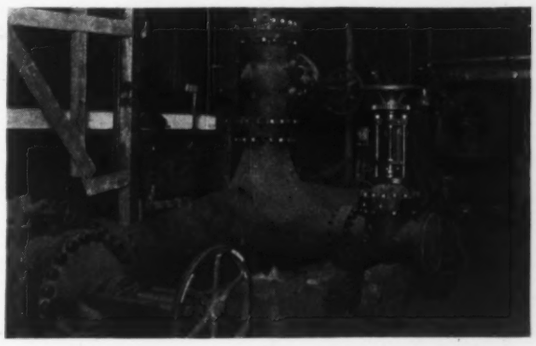


Fig. 1—Eight ton cast steel manifold in main steam piping of Trenton Channel Power Plant (built 1922-26)

Fig. 2—Assembly of heavy cast steel fittings in main steam piping of the old Conners Creek Power Plant (built 1914-1920)

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marked a degree. For this article it has been possible, however, to obtain photographs for two instances of very direct comparison. The assembly of cast steel fittings of the old Conners Creek Power Plant shown in Fig. 2 was

a

b *c* *d*

Fig. 3*a*—Light weight welded steel manifold in main steam piping of the rebuilt Conners Creek Power Plant (built 1934-36) serving similar purpose to Fig. 1. *b*—Composite reinforcement. *c*—Saddle type reinforcement. *d*—Ring type

the prototype of the welded manifolds, Fig. 3, installed during 1934 to 1936 while rebuilding that plant. Three different types of reinforcement which have been used there around welded branch connections are shown in *b*, *c* and *d*.

Another contrast between old and new is afforded by Figs. 4 and 5 showing the juncture of two boiler leads in a breeches fitting as done in the old and new Conners Creek plants respectively. Some originality was required in finding out how to build the welded fitting without resorting to a wye design which is inherently weak. The problem was solved eventually by cupping a thick walled cylinder out of steel plate, swaging down the open end to the required size, and cutting twin holes in the thick head. While the hemispherical head probably was heavy enough to support the twin holes without reinforcement, such was provided anyway as an extra precaution. A view of the manifold in place is shown in Fig. 5*a*, while a close-up with one reinforcing ring already attached and the other still loose is shown in *b* of the same figure, and another close-up with both reinforcement rings in place and the supporting brackets attached is shown in 5*c*.

An advantage of welded construction of high pressure, high temperature piping lies in the use of fabricated parts for cumbersome, heavy cast manifolds and special fittings. . . . The Detroit Edison Co. has made wide use of fabrication of such parts by welding, and Mr. Crocker gives detailed instructions for such work in this article, which piping design engineers, contractors, and fabricators will find a valuable reference

Fabrication by Welding

The fabrication by welding of a manifold such as that shown in Fig. 3 for severe service conditions is not a particularly difficult job, although it is one which warrants careful attention both to design details and selection of a competent welder. While an equivalent manifold could be built up for some conditions out of ready-made welding tees and elbows, the required fittings are not always available, particularly in the heavy wall thicknesses required for pressures of 600 lb per sq in. or more at temperatures of 800 to 900 F. Furthermore the extra cost of the ready-made fittings coupled with the additional welds required to build them into a manifold is apt to swing the choice to an article fabricated out of pipe as shown in Fig. 3, in which branch connections are made with "fish mouth" welds (see Fig. 6) and bends made with curved pipe. Some discussion of the problems involved in fabricating such manifolds would seem of interest at this time.

In so far as possible the work should be laid out and executed under the equivalent of shop conditions, that is by placing it on the floor where it can be turned as required so that cutting and welding for branch connections are carried on in a downward position and in an unhampered manner. This is doubly desirable in that fish mouth welds can be stress relieved to best advantage in a furnace rather than with portable equipment in the field, thus prompting the recommendation that large manifolds be built in sections of a size which can be put in the furnace, and subsequently connected in position with circumferential line joints which can be stress relieved with a portable annealer. Whether fabrication of a welded manifold or other special fitting is to be carried on in a contractor's plant or in a field pipe shop is a choice largely of convenience, relative cost and available personnel.

Mitering and Bevelling

Preparing the header and branch for a miter or fish mouth weld requires careful cutting by template to an irregular shape, usually followed by bevelling the edges to a varying degree around the opening. Adequate instructions for laying out and making templates will be found in trade bulletins and need not be described in detail here. For high pressure service, however, more than ordinary care should be given to the matter of bevelling and some remarks on this score may be of interest.

Where the branch is considerably smaller

than the header, the branch pipe may be inserted through the opening down to the inner surface of the header so as to completely match the cut all around its periphery, thus affording an excellent vee for welding. In cutting the opening in the header, the torch should be held radially, that is perpendicular to the surface, at all times and the edges of the hole bevelled outwardly later to permit penetration of the weld to the inner wall of the header. No bevelling is required on the branch pipe where it enters the header, and the only cutting required on this member is to give the end entering the header sufficient nosing to match the bore of the header.

Cutting and scarfing for a full size branch connection weld is somewhat more involved. With an equal diameter branch pipe its theoretical side intersections with the header come diametrically opposite the center line. To avoid making this sharp-pointed weld in high pressure piping, it is necessary to shorten both the crosswise dimension of the opening in the header, and the long elements of the branch nose to give a rounded intersection. In this type of joint, the outside surface of the branch fully enters the header to its inner wall only at what might be termed the top of the header, while on the side the walls of header and branch (of equal diameter) must coincide rather than overlap. Between these two extremes the intersection and degree of scarfing on each member must be varied progressively to afford the most effective welding vee. At the top the header only is bevelled, preferably to an angle of about 60 deg, while on the side both header and branch are bevelled so as to

Fig. 4—Juncture of two boiler leads in a cast steel breeches fitting, old Conners Creek Power Plant

give a total included angle of 90 to 120 deg. This gives a vee having considerable warp as it progresses around the opening. An idea of how this scarf appears in a full size branch connection can be obtained from the photograph of a model shown in Fig. 6.

In another variety of scarfing sometimes used for branch connection welds, the hole in the header is cut to match the bore of the branch at all points around the opening. The end of the branch is then bevelled to about a 60 deg angle all around, while the opening in the header is left as a radial cut without bevelling. This design is claimed to have advantages through minimizing the size of opening cut in the header with a corresponding reduction in the amount of reinforcement required.

Reinforcement of Branch Opening

The matter of when and how to reinforce branch connection welds also warrants careful consideration. While no definite rules have been laid down as yet in piping codes, some precedent exists in the *A.S.M.E.* Boiler Construction Code and in the Joint *A.S.M.E.-A.P.I.* Code for Unfired Pressure Vessels for Petroleum Liquids and Gases. These codes require that all openings greater than a prescribed minimum size, which are cut in a vessell wall, shall be reinforced by the addition of sufficient metal in the area immediately surrounding the opening to compensate for material removed in cutting the hole.

Generally speaking, neither code requires the reinforcement of openings smaller than 2 in. diameter; the joint code requires that all openings over that size be reinforced; and the *A.S.M.E.* code provides a chart for determining the maximum permissible size of unreinforced openings and makes the further reservation that all openings over 8 in. diameter shall be reinforced. This chart is reproduced here as Fig. 7 on the supposition that since piping designers are not necessarily familiar with the design of power boilers and unfired pressure vessels, many of them may find the chart of interest. In the attachment of nozzles to boilers and pressure vessels one would not expect the diameter of the branch connection to exceed about 25 per cent of the diameter of the drum or vessel itself. The use of full size branch connections in piping work may be attended with the need for more elaborate reinforcement than is the case where the relative size of the branch opening is 25 per cent or less. Hence, in extending the use of the boiler code rules to full size, branch connection piping welds, due allowance should be made for the fact that the boiler code rules deal more with what approaches a round opening in a flattish surface, while the extreme piping application is a "fish mouth" opening in a relatively curved surface.

Where reinforcement is called for the boiler code requires that it be provided within the rectangle *A-B-C-D* shown in the sketch identified as Fig. 7a, using a ring or flange whose cross-sectional area is equal to that of the metal cut out in making the opening, minus credit for a 2 in. diameter hole which needs no reinforcement. The portion of the branch pipe coming within the rectangle *A-B-C-D* is counted as reinforcement, as also are weld metal and any extra shell thickness over and above the minimum required by formula. The most effective sort of reinforcement for boiler nozzles was described as follows in an *A.S.M.E* paper by J. Hall Taylor and Professor E. O. Waters[1]. ". . . the actual connection between the reinforcing member and the pressure vessel should be as rigid as possible. Furthermore, the point of attachment should be as near the edge of the hole as practicable, to eliminate dead metal in the shell, and the reinforcing ring itself should be concentrated close to the edge of the hole, so as to distribute the stress more uniformly through it, and prevent the bending effects that are associated with broad, stiff rings attached to the shell at or near their outer edges." In other words

[1] "The Effect of Openings in Pressure Vessels," by J. Hall Taylor and Everett O. Waters, *A. S. M. E. Transactions*, 1934, Vol. 56, pp. 119-140, APM-56-3.

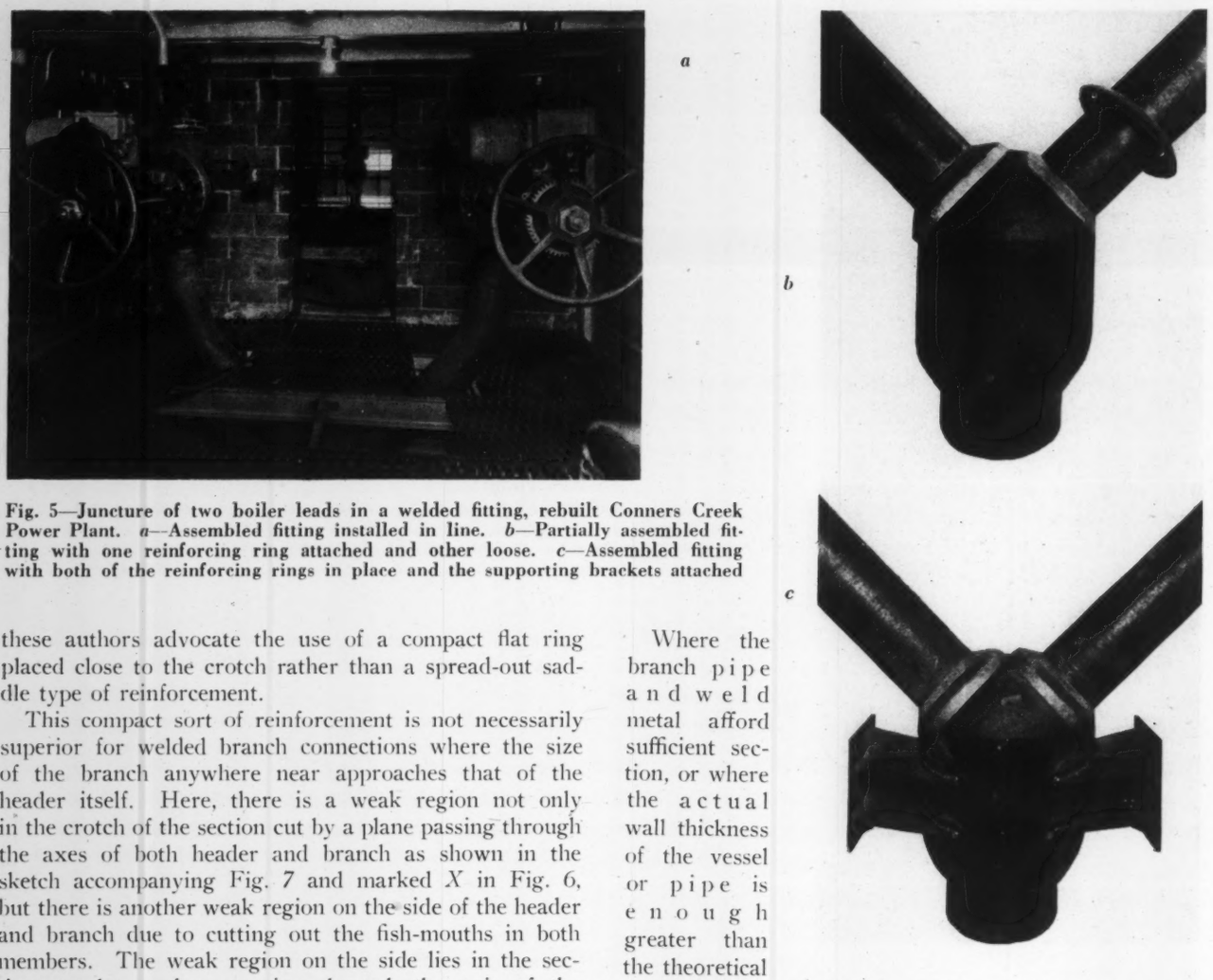


Fig. 5—Juncture of two boiler leads in a welded fitting, rebuilt Conners Creek Power Plant. *a*—Assembled fitting installed in line. *b*—Partially assembled fitting with one reinforcing ring attached and other loose. *c*—Assembled fitting with both of the reinforcing rings in place and the supporting brackets attached

these authors advocate the use of a compact flat ring placed close to the crotch rather than a spread-out saddle type of reinforcement.

This compact sort of reinforcement is not necessarily superior for welded branch connections where the size of the branch anywhere near approaches that of the header itself. Here, there is a weak region not only in the crotch of the section cut by a plane passing through the axes of both header and branch as shown in the sketch accompanying Fig. 7 and marked *X* in Fig. 6, but there is another weak region on the side of the header and branch due to cutting out the fish-mouths in both members. The weak region on the side lies in the section cut by a plane passing through the axis of the branch pipe and perpendicular to the axis of the header, marked *Y* in Fig. 6. Obviously each intervening section between these two extremes has been weakened to a varying extent through cutting the fish mouths and requires a corresponding degree of support. Several types of reinforcement are available, three of which are shown in Fig. 3. While that shown in Fig. 3*d* most nearly approaches the reinforcement for openings in boilers and pressure vessels preferred by Taylor and Waters, it is somewhat deficient in side support when applied to branch connections approaching full size. On the other hand, the reinforcement of Fig. 3*c* is too far spread out to afford the "concentrated support close to the edge of the hole" recommended in their paper, and that of Fig. 3*b* is too elaborate and costly. For full-size branch connections requiring optimum support it would seem preferable therefore, to cut down the saddle reinforcement of Fig. 3*c* to something approaching the ring of Fig. 3*d*, but still retaining enough collar or flange effect to afford the requisite side support. For most applications, however, it would appear that either the saddle reinforcement (Fig. 3*c*) or the ring (Fig. 3*d*) is entirely adequate for the purpose. A subcommittee on welded branch connections of the *A.S.A.* sectional committee on code for pressure piping has under consideration at the present time the development of safety rules for reinforcing such connections.

Where the branch pipe and weld metal afford sufficient section, or where the actual wall thickness of the vessel or pipe is enough greater than the theoretical thickness, it is obvious that no further reinforcement is necessary. No reinforcement is required, for instance, in making even a full size welded branch connection in a run of standard weight pipe comprising part of a low pressure building heating system, since the pipe wall is of more than ample thickness with respect to the customary working pressure of not to exceed 15 lb per sq in. ga. The fact that a simple fish mouth weld is sufficient here without resorting to a supplementary saddle flange or reinforcing ring is well established by countless installations. Indeed there is a rule-of-thumb followed by some fabricators to the effect that no welded branch needs reinforcement unless the diameter of the branch is equal to or greater than one-half the diameter of the main pipe. While this rule may do for low pressure work, it undoubtedly is too liberal for higher pressures in cases where the wall thickness of either the header or branch is barely sufficient for the actual working pressure, and adherence to boiler code rules in the absence of piping code requirements would be safer practice. This is best illustrated by an example.

Typical Example for Reinforcement

Take for instance the case of the 10 in. header for the Conners Creek Power Plant shown in Fig. 3. The maximum steam conditions of 650 lb ga at 850 F expected at this point call for a 0.593 in. wall thickness in

10 in. pipe made of Grade B material which can be determined as follows from Section 122 of the *A.S.A.* Code for Pressure Piping:[2]

$$t_m = \frac{PD}{2S} + C$$

where t_m = minimum pipe wall thickness in in. allowable on inspection
P = maximum internal service pressure in lb per sq in. ga
D = actual outside diameter of pipe in in.
S = allowable stress in material, lb per sq in.
C = allowance for threading, mechanical strength, and/or corrosion in in.

The allowable stress S at 850 F for Grade B pipe material of *A.S.T.M.* Specification A106 is 7,520 lb per sq in.; the corrosion allowance C for plain end pipe intended for welding is 0.065 in.; hence

$$t_m = \frac{650 \times 10.75}{2 \times 7{,}520} + 0.065 = 0.529 \text{ in.}$$

The nominal thickness $= t_m \div 0.875 = 0.529 \div 0.875 = 0.605$. Therefore Schedule 80 10 in. pipe 0.593 in. thick almost satisfies code rules for the service conditions. The actual physical properties of the pipe, however, turned out to meet the requirements for Grade C pipe assigned in the Code for Pressure Piping with an allowable working stress of 9,300 lb per sq in. at 850 F, so that there actually is considerable margin on the safe side.

Applying the boiler code rules for determining the maximum permissible size of unreinforced opening (see Sections P-268 or U-59 of the 1935 edition) and using again the allowable stresses prescribed in the Code for Pressure Piping:

d = maximum allowable diameter of opening, in.
D = outer diameter of shell, in.
t = actual thickness of shell, in. (corresponds to $t_m - 0.065$)
$K = PD/2St$
P = working pressure, lb per sq in.
S = allowable working stress, lb per sq in.

Solving for K and Dt on the basis of Grade B properties and obtaining d from the chart on Fig. 7.

$$K = \frac{650 \times 10.75}{2 \times 7{,}520 \times 0.455} = 1.00 \qquad Dt = 4.9 \qquad d = 1.0 \text{ in.}$$

Solving for K on the basis of Grade C properties

$$K = \frac{650 \times 10.75}{2 \times 9{,}300 \times 0.455} = 0.825 \qquad Dt = 4.9 \qquad d = 2.6 \text{ in.}$$

The significance of which is that with Grade B pipe steel, any opening in this manifold over 1 in. diameter should be reinforced, while with Grade C pipe steel any opening up to 2.6 in. actual diameter need not be reinforced. In this connection it should be borne in mind that the branch pipe and weld metal in themselves may constitute sufficient reinforcement and in any event count toward the reinforcement as previously described. Three types of reinforcement used at Conners Creek for 650 lb, 850 F service conditions are shown in Figs. 3*b*, *c*, and *d*.

Importance of Sound Welds

In closing any exposition of welded fabrication for piping it is difficult to over-emphasize the importance of having all welding done by fully competent welders who have met qualification tests at least equal to those prescribed in the *A.S.A.* Code for Pressure Piping for the class of work involved. Welding truly is an art requiring a high degree of skill, and only the most proficient operators should be allowed to practice on pressure piping. Even then some non-destructive method for examining welds by which the occasional flaw can be detected and eliminated is greatly to be desired in the case of piping for severe service conditions. Where applicable, x-ray or gamma-ray examination is a useful check, although unfortunately it is not readily applied to branch connection welds or to line joints made in the field. Under these circumstances the "Arcronograph"[3] has been found a most useful device for continuously checking the uniformity of conditions under which weld metal is applied. This instrument draws a graph showing the degree of uniformity in depositing weld metal maintained by the operator, thus providing a record from which possible flaws can be detected and cut out while the work is still in progress. Then, too, the matter of stress relief for welds is important, particularly with the unequal strains set up in making "fish mouth" welds for branch connections. Where a furnace anneal is impracticable the best means possible should be applied in the field. The need for relieving locked in stresses is particularly manifest in this type of work by the tendency during fabrica-

[2]Pipe wall thicknesses for the first section of the rebuilt plant actually were established with reference to creep tests before the Code for Pressure Piping was published. Allowable working stresses due to bursting pressure were set at 7,000 to 7,500 lb per sq in. as representing two-thirds of the stress which would give a creep rate of one per cent in 100,000 hours at 850 F.

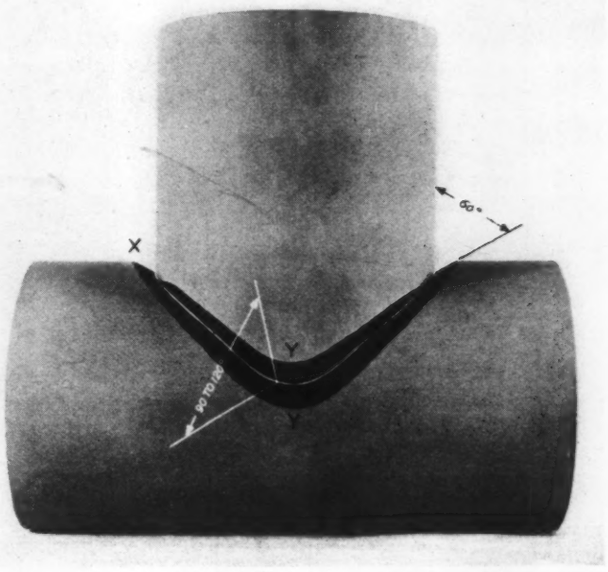


Fig. 6—Model of full-size branch connection prepared for welding, showing method of scarfing used by The Detroit Edison Co. for high pressure "fish mouth" welds, and location of sections considered for reinforcement

[3]"Evolution of the Arcronograph," by Bela Ronay, *Journal* of the *American Society of Naval Engineers*, August, 1934.

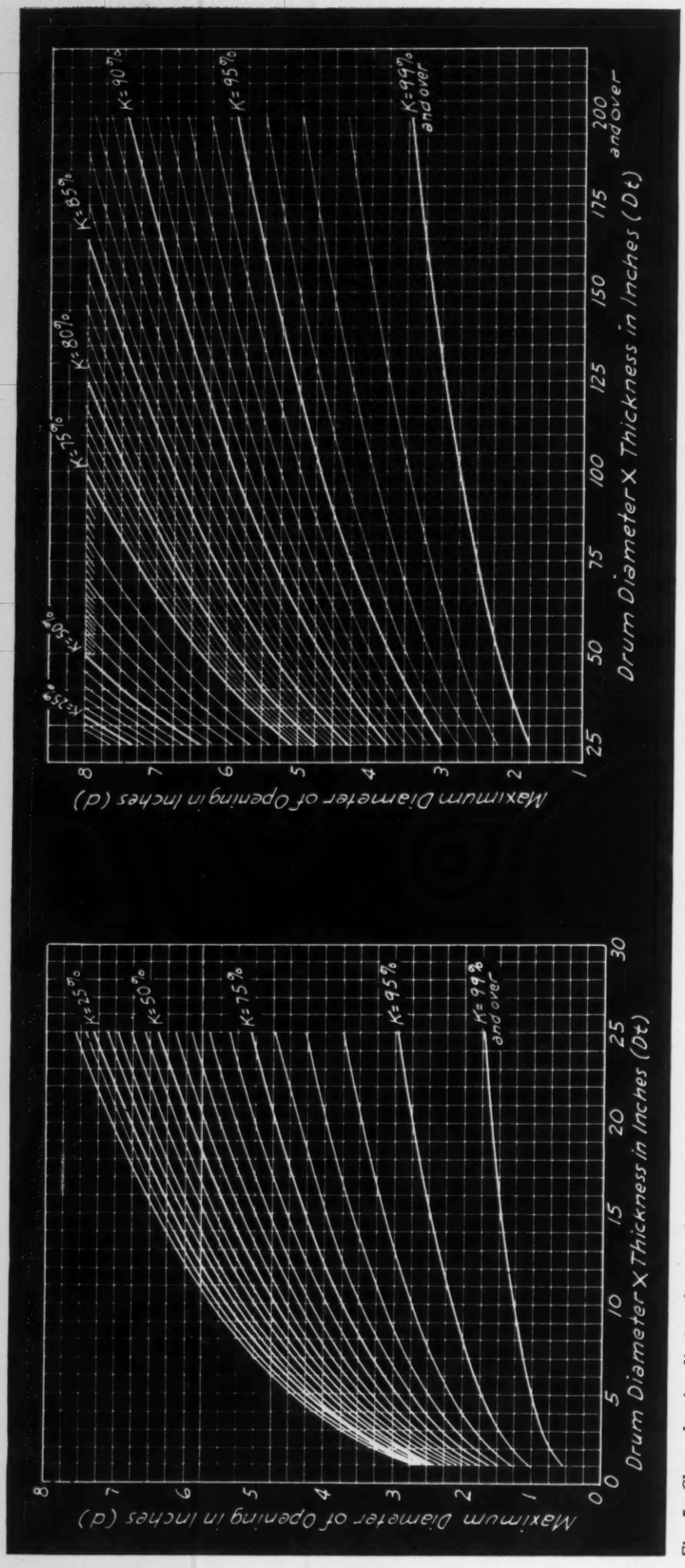


Fig. 7—Chart showing limits of sizes of unreinforced openings in cylindrical shells, from A. S. M. E. boiler construction code, 1935 edition (Reproduced by permission)

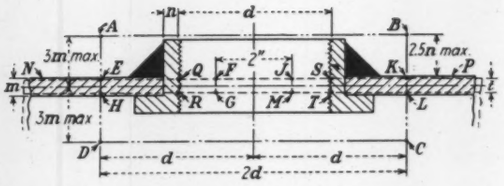


Fig. 7*a*—Section cut by plane passing through axes of vessel and nozzle

tion for the header to bow or hump out of a straight position.

There is a distinct advantage also in using multi-pass welds in pipe joints for severe service conditions. It has been found desirable to specify that there be at least one layer per ⅛ in. of pipe wall thickness, and that in any joint no matter how thin walled, there shall be not less than two layers. The purpose in restricting the depth of metal deposited in a single layer is two-fold. First, by restricting the depth of the deposit, one restricts the depth of any fault that may occur and at the same time increases the probability that any faults which do exist can be seen and removed prior to deposition of the succeeding layer. Second, such a restriction insures that each layer will be thoroughly heated, during the deposition of the succeeding layer, to a temperature sufficient to produce complete grain refinement. Weld metal exists in the joint in the "as deposited" condition only in the last layer of the reinforcement. The superiority, particularly under dynamic loading, of weld metal refined by the deposition of succeeding layers over weld metal in the "as deposited" condition is well known.

The benefits of multiple layer welding can be realized to the fullest extent only when very thorough cleaning of each layer is carried out. This cleaning should provide thorough removal of the slag deposited by the electrode and the removal of all surface defects and areas where subsurface defects are suspected. At the same time, the surface of the deposited metal and of the exposed faces of the base metal should be prepared for the deposition of the following layer. This preparation should include the removal of lumps and the elimination of sharp corners or grooves into which the metal might not flow readily.

In The Detroit Edison Co., such cleaning is done with pneumatically operated tools. A helper is assigned to the welder to do this, since the arm fatigue resulting from operation of the pneumatic tool is almost sure to prevent the welder from exercising the full degree of skill which he possesses.

A Graphical Method for the Design of Exhaust Systems

By **Arthur Nutting***

PURPOSE of the chart on page 22 is to eliminate arithmetical calculations in the design of an exhaust system by permitting friction losses and air quantities to be plotted graphically. In addition to saving time, the chart provides a convenient method for preserving a complete record of calculations for every job and enables the designer to observe at a glance the relation of the various factors in the system.

The chart is based on the assumption that 55 pipe diameters of duct will cause a resistance of one velocity head, and the elbow will cause a resistance of 10/55 of one velocity head. Although these assumptions are not absolutely accurate they are well within the limits of reasonable design accuracy.

For any system, the suction read in the branch at the hood is a function of the entrance loss caused by the hood and the velocity of air flowing in the branch. The entrance loss caused by the hood is a matter of the designer's experience and must always be estimated unless the particular design of hood has been previously used. A definite suction at the hood is usually prescribed by code or practice, depending on the nature of the installation, but frequently the system is designed for a definite velocity in the branches without regard to suction as a measure of air velocity. The relationship between suction or pressure in the branch, velocity in the branch and entrance loss is plotted on Chart *A*, so that if any two of the variables are known the other can be found.

Example Shows Use of Chart

To illustrate the use of this chart we will design the system sketched at the top in the space provided for that purpose. This particular system is to exhaust from four dust sources situated at points *a, b, c* and *d*, and the existing code requires that 5, 4, 4½ and 4 in. branches respectively be connected to the hoods and further that a 3 in. suction be maintained in the branches behind the hoods. We will assume that all the hoods are alike in design and that they cause an entrance loss of 0.58 velocity head. Due to the nature of the dust it is desirable to install a precleaner to drop out the heavy particles and its resistance we know to be one velocity head. The relative locations of the dust sources, exhauster and discharge point fixes the length of branches, length of mains and number of elbows in the system, as indicated in the sketch.

These are all the known factors. The unknowns to be determined from the chart are diameters of mains, total pressure of the system and air volume to be handled by the exhauster. The total pressure of the system will be determined from the resistance of the longest or most restricted run of pipe and in this case it is the run from dust source *a* to the exhauster.

Assuming a 3 in. suction at hood *a* and an entrance loss at the hood of 0.58 velocity head, on chart *A* at the intersection *B* of the 3 in. pressure line with the 0.58 entrance loss line, read down to find a 5400 fpm velocity in the branch *a*. To find the air volume in branch *a* refer to chart *B* and at the intersection of the 5 in. diameter line with the 5400 fpm line at point *C* read up to find 740 cfm. Project the 740 cfm on to chart *C* and at point *D* on the chart we have the flow conditions behind the hood.

It is now necessary to find the resistance caused by the 10 ft of 5 in. branch pipe *a*. On chart *D* at the intersection of the 5 in. diameter line with the 10 ft duct length line at point *E*, read down to find a value of 22 units of $1/A^2$ (which we will hereafter call *blast area value*). At point *D* on chart *C* we have a blast area value of 89, as indicated by the sloping lines, and adding the 22 units obtained from chart *D* we have a blast area value of 111, which locates point *F*. The difference in pressure as read to the left of the chart between points *D* and *F* is the resistance of the branch.

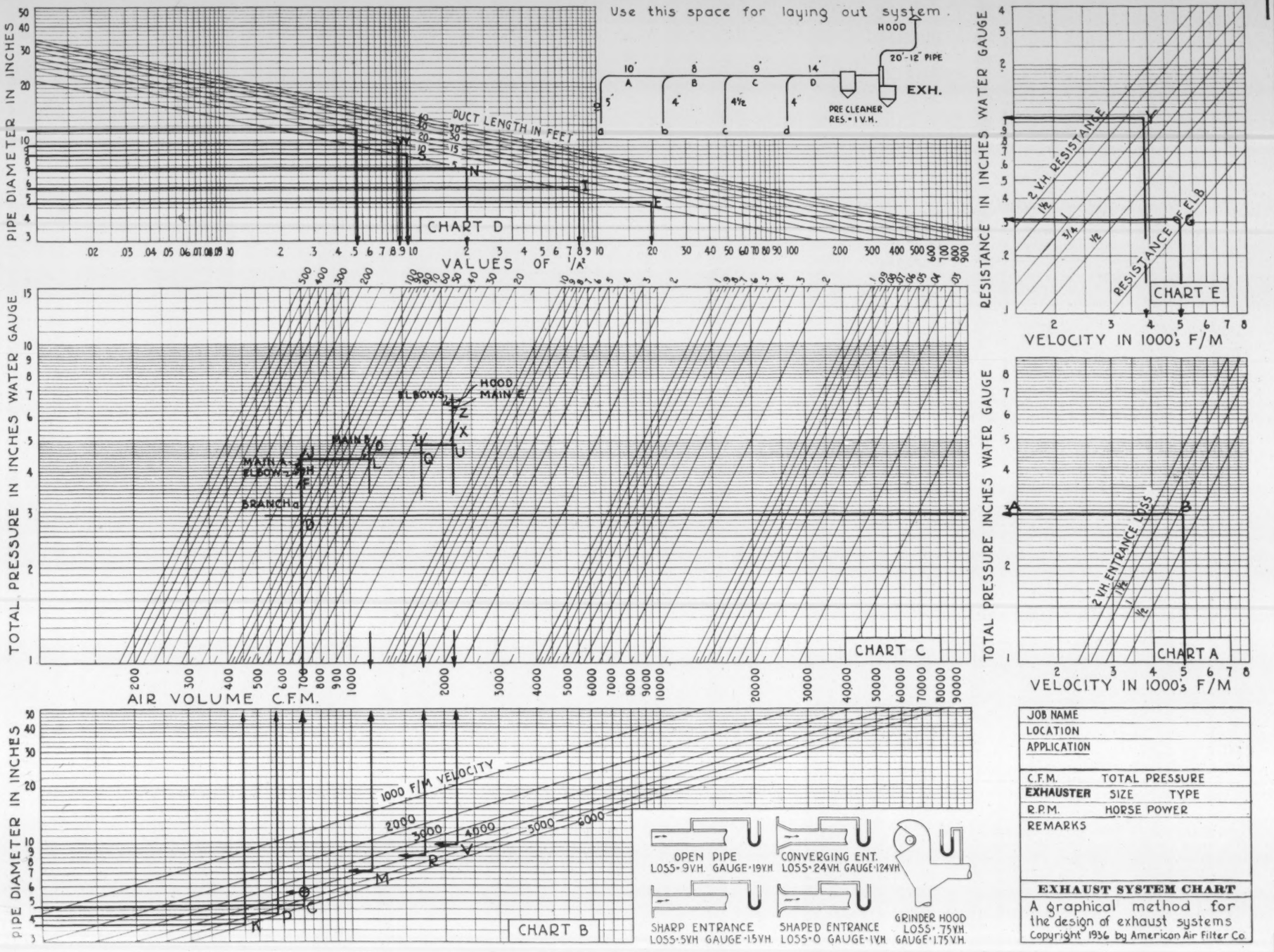
To determine the resistance of the elbow in branch *a*, refer to chart *E* at the intersection of the 5400 fpm line with the elbow resistance line at point *G* and read 0.32 in. This value is added on chart *C* to point *F* to give the new point *H*.

Assuming that a 4000 fpm velocity in the main is sufficient to convey the dust, our next problem is to determine the size and resistance of main *A*. On chart *B*, at the intersection of the 740 cfm line and 4000 fpm velocity line, we find a pipe diameter of 5¾ in. but use a 6 in. diameter, the closest size standard pipe. After noting the size of main on our layout sketch we proceed to find the blast area value of the 10 ft of 6 in. main. On chart *D*, at the intersection of the 6 in. pipe diameter line with the 10 ft duct length line (point *I*) read down to find a blast area value of 9. After adding these 9 units to the blast area value of point *H*, as indicated by the sloping lines, we have point *J* and as before, the difference in pressure between *H* and *J* as read to the left is the resistance of main *A*. Point *J* is a measure of the pressure and air volume which exists in the main just ahead of the branch *b* junction.

To find the air volume in 4 in. branch *b*, refer to chart *B*. At point *K*, the intersection of the 4 in. pipe line with the 5400 fpm line, read up to find an air volume of 470 cfm. After projecting horizontally from point *J* 470 units of cfm, we have point *L* on chart *C*, which indicates a total air volume of 1210 cfm for branches *a* and *b*. Main *B* is sized to handle this 1210 cfm at a 4000 fpm velocity by projecting down from point *L* on to chart *B* to the 4000 fpm line. At the intersection *M* a 7½ in. main is indicated. The resistance of the 8 ft main *B* is found by first finding its blast area value on chart *D*. At the intersection of the 7½ in. diameter line with 8 ft duct length line, read down to find a blast area value of 2.2. This value added to point *L* locates point *O* and the pressure they intercept on chart *C* equals the resistance of main *B*.

The air volume in branch *c* is found on chart *B* to be 600 cfm by intersecting the 4½ in. pipe diameter line with the 5400 fpm velocity line at point *P*. This 600 cfm is added on chart *C* to the volume indicated by point *O* and the new volume at point *Q* is the volume flowing through main *C*. This volume is projected down from *Q* on to chart *B* to the 4000 fpm velocity line and we find main *C* should be 9 in. in diameter to carry this volume at 4000 fpm.

*Chief Research Engineer, American Air Filter Co., Inc., Louisville, Ky.


Use this space for laying out system.
HOOD
20'-12" PIPE
EXH.
PRE CLEANER RES. = 1 V.H.
10' A
8' B
9' C
14' D
5' a
4" b
4½ c
4" d
PIPE DIAMETER IN INCHES
DUCT LENGTH IN FEET
VALUES OF 1/A²
CHART D
RESISTANCE IN INCHES WATER GAUGE
2 V.H. RESISTANCE
RESISTANCE OF E.L.B.
CHART E
VELOCITY IN 1000's F/M
TOTAL PRESSURE IN INCHES WATER GAUGE
ELBOWS
HOOD
MAIN E
MAIN D
MAIN A
ELBOW
BRANCH a
CHART C
AIR VOLUME C.F.M.
2 V.H. ENTRANCE LOSS
CHART A
VELOCITY IN 1000's F/M
PIPE DIAMETER IN INCHES
1000 F/M VELOCITY
2000
3000
4000
5000
6000
CHART B
OPEN PIPE
LOSS=9V.H. GAUGE=1.9V.H.
CONVERGING ENT.
LOSS=.24V.H. GAUGE=.124V.H.
SHARP ENTRANCE
LOSS=.5V.H. GAUGE=.15V.H.
SHAPED ENTRANCE
LOSS=.0 GAUGE=.1V.H.
GRINDER HOOD
LOSS=.75V.H.
GAUGE=1.75V.H.
JOB NAME
LOCATION
APPLICATION
C.F.M.
TOTAL PRESSURE
EXHAUSTER
SIZE
TYPE
R.P.M.
HORSE POWER
REMARKS
EXHAUST SYSTEM CHART
A graphical method for the design of exhaust systems
Copyright 1936 by American Air Filter Co.

On chart D the blast area value of the 9 ft of 9 in. main C is found to be 1.1. This added on chart C to point Q gives us point T, the suction and air volume just ahead of the branch d junction.

The volume flowing in branch d is the same as in branch b, that is 470 cfm. Adding this volume to point T on chart C we find point U, indicating a total air volume of 2300 cfm, and projecting point U on to chart B to the 4000 fpm line at point V we find the proper diameter of main D to be 10 in. The actual velocity in main D using the 10 in. pipe is read to be 4200 fpm.

The blast area value of 14 ft of 10 in. main D is found on chart D to be 0.95. This value added to point U gives us point X and again the pressure difference as intercepted by points U and X is the resistance of main D.

The resistance of the precleaner we have assumed to be equal to one velocity head. To find its actual resistance, refer to chart E and project upward at 4200 fpm to Y, the one velocity head resistance line. Read to the left to find a precleaner resistance of 1.1. This amount of resistance is added to the pressure indicated by point X and gives us the point Z which is the total suction on the inlet of the exhauster.

In order to reduce the pressure loss in the discharge piping, the discharge pipe is enlarged to permit a velocity of about 3000 fpm. Projecting from U on chart C to the 3000 fpm line on chart B we find a 12 in. pipe necessary for the discharge main E. The blast area value of main E and resistance of the elbows and weather hood is added to point Z and the graphical plotting of all pressure and volume factors of the system is completed and shows a pressure requirement for the exhauster of 6.9 in. water gauge, and air volume of 2300 cfm.

Space is provided at the bottom of the chart for tabulating the selection of the exhauster and the chart can be filed with the job for easy reference. If it is decided later to increase the suction at the hoods by speeding up the exhauster, the new total pressure and air volume can be read directly from chart C as follows:

At point D we have 3 in. suction and 740 cfm indicated in hood a. If the air volume is varied in the hood the suction will vary in such a way that point D must always remain on the blast area value 89. This is true because the blast area value is dependent only on the shape of the hood and not on the air volume. If 4 in. suction at the hood is required, point D is moved along the blast area line to the 4 in. total pressure line, and reading down we note the new volume will be 850 cfm. Likewise, the new total pressure and air volume of the system are found by moving the point marked "Hood" along its blast area line the same distance point D was moved, and the new total pressure will be 9.1 in. W. G., and air volume 2650 cfm.

Theory of the Method

The elimination, by this graphical method, of the actual calculation of the resistances in the system is possible because of the following laws:

(1) Any systems or parts of systems having equal blast areas will have equal resistances for the same air volume flow.

(2) For a system having parts in series the square of the reciprocal of the system blast area equals the sum of the square of the reciprocals of the blast areas of the various parts of the system. Mathematically this is expressed:

$$\frac{1}{A_0^2} = \frac{1}{A_1^2} + \frac{1}{A_2^2} + \frac{1}{A_3^2} \quad . \quad . \quad . \quad .$$

where A_0 = blast area of the system; A_1, A_2, A_3 etc., = blast area of various parts.

(3) For a system having parts in parallel, the blast area of the system equals the sum of the blast area of the various parts, as follows:

$$A_0 = A_1 + A_2 + A_3 \quad . \quad . \quad . \quad .$$

It is on these theorems that charts C and D are constructed, and a mathematical analysis of their construction follows.

For any pipe system there can be substituted a theoretical shaped orifice or nozzle having no resistance to air flow, which will pass the same air volume at a pressure differential equal to the pressure loss in the system. The area of this theoretical orifice will correpond to what is known as the blast area of the system. For instance, if

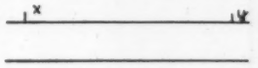


Fig. 1

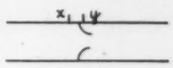


Fig. 2

the pressure loss between x and y in Fig. 1 equals the pressure differential around the shaped orifice in Fig. 2 and the same volume of air is flowing, then the area of the orifice equals the blast area of system Fig. 1, assuming of course that the orifice is frictionless. The pressure difference around the orifice will equal the velocity pressure in the throat of the orifice. The blast area, therefore, is defined as the area which will pass the same quantity of air at a velocity corresponding to the resistance loss of the system.

Now, the velocity in the throat of the orifice is expressed—

$$\text{Velocity} = 4005\sqrt{V.P.}$$

and the $V.P.$ as explained above corresponds to the differential pressure around the orifice which equals the $T.P.$ loss of the system of Fig. 1. Since

$$\text{Area} = \frac{\text{Volume}}{\text{Velocity}}$$

The area of the orifice, therefore, is expressed

$$A = \frac{cfm}{4005\sqrt{V.P.}}$$

This gives us the equation for blast area:

$$\text{Blast area of system} = \frac{cfm}{4005\sqrt{T.P.\text{ loss}}} \quad \ldots\ldots\ldots\ldots [1]$$

In Fig. 3, orifices A_1, A_2 and A_3 represent parts of a system in series, each part causing a $T.P.$ loss of P_1, P_2 P_3 respectively:

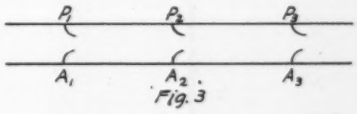


Fig. 3

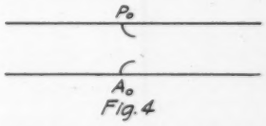


Fig. 4

In Fig. 4 the orifice A_o is of such size that it will pass the same air volume as the system in Fig. 3, and at a pressure so that

$$P_0 = P_1 + P_2 + P_3$$

By definition, the area of A_0 equals the blast area of the $A_{1\text{-}2\text{-}3}$ system. Now,

$$P_1 = \left(\frac{cfm}{4005\,A_1}\right)^2 \text{ and } P_2 = \left(\frac{cfm}{4005\,A_2}\right)^2 \text{ etc,}$$

Therefore,

$$P_0 = \left(\frac{cfm}{4005\,A_1}\right)^2 + \left(\frac{cfm}{4005\,A_2}\right)^2 + \left(\frac{cfm}{4005\,A_3}\right)^2$$

$$= \left(\frac{cfm}{4005}\right)^2 + \left(\frac{1}{A_1^2} + \frac{1}{A_2^2} + \frac{1}{A_3^2}\right) \quad \text{.....[2]}$$

This equation is used to construct chart *C* on which we can add the $1/A_0^2$ value of any duct as found on chart *D*.

Assuming that 55 diameters of duct offers a resistance of one velocity head:

$$P_0 = \frac{L}{D}\,\frac{1}{55}\left(\frac{cfm}{4005}\right)^2 \frac{1}{A^2} \quad \text{.....[3]}$$

where A = Actual area of duct, sq ft
L = Length duct, ft
D = Diameter duct, in.
P_0 = Total pressure loss in duct, in. of water

Substituting by Eq. 2

$$P_0 = \left(\frac{cfm}{4005}\right)^2 \frac{1}{A_0^2} = \frac{L}{D}\,\frac{1}{55}\left(\frac{cfm}{4005}\right)^2 \frac{1}{A^2}$$

$$\frac{1}{A_0^2} = \frac{L}{D}\,\frac{1}{55}\,\frac{1}{A^2} \quad \text{.....[4]}$$

This equation is used in the construction of chart *D* from which the $1/A^2_0$ value of any round duct can be found when its diameter and length are known.

Factors Involved in Exhaust System Design

It may be well to point out some of the factors involved in designing an exhaust system.

The design of hoods is largely a matter of experience. They should be so constructed that the waste material will be directed at the point of highest velocity and as nearly as possible parallel to the air flow to aid conveyance. Poorly designed hoods will cause excessive pressure losses with resultant power waste and will fail to confine the dust.

The effectiveness of a hood is dependent upon the air volume passing through it which must be large enough to create air velocities at the dust source of sufficient intensity to prevent normal diffusion of the dust. Various state codes specify the suction to be maintained at the hoods, the intent being to regulate the air volumes, but few of these codes are in agreement. These codes prescribe several methods for measuring suction, and a few of the methods are entirely meaningless. The suction reading at the hood is no measure of the air quantity unless the entrance loss of the hood is known.

The entrance loss in hoods is usually 0.5 to 1.0 velocity head but in most cases should be assumed to be one head. The suction at the hood is generally read through a small hole drilled in the branch pipe a few diameters from the connection and when read in this manner the suction will be two velocity heads when the entrance loss is one head. Some states require that a tube be inserted about 1 in. in the branch and the reading in this case will approximate 2.5 velocity heads. Other states require the branch to be closed when the suction is read and the reading will approximate 3.0 velocity heads. Since no air is flowing through this branch, however, and since all the other branches are open, readings made in the last manner are affected by the number of branches, length of system, and the fan characteristics.

In order to comply with some of the regulations it often is necessary to maintain velocities so excessive that the wasted power is the greater part of the total power. The choice of correct velocities for conveyance of the material to be handled is the most important determination a designer must make and it is imperative that excessive velocities be avoided. The power required for any system varies as the cube of the velocity and a waste of 41 per cent occurs, for instance, when 4500 fpm is used where 4000 fpm would be sufficient.

Advantages of an Air Conditioned Hospital

A special meeting of the Air Conditioning Bureau of Boston on November 27 marked the complete air conditioning of the Corey Hill Hospital at Brookline, Mass. Some 60 bedrooms for patients, two main operating rooms and the adjoining suites are equipped for year 'round conditioning by a system combining a lithium chloride dehumidifier and mechanical refrigeration.

Dr. Albert G. Young, medical director of the hospital and responsible for its air conditioning, was the first speaker at the meeting, which was presided over by Julius Daniels. Dr. Young said that for years the medical profession has realized the importance of climatic environment on the patient's welfare, but it has been only through recent developments in the field of engineering that it has been possible to control such conditions.

His first task, he said, was to determine what range of temperature and relative humidity was most beneficial for the patient, and that because of his interest in arthritis and rheumatic fever he had approached the study from the standpoint of patients suffering from rheumatic diseases. By a careful study of the climatic conditions in those regions known to be the most beneficial to rheumatic patients, he had learned that a relative humidity of 25-30 per cent was desirable.

As his studies continued, he realized the importance of controlling those factors in the care of patients suffering from other diseases, and therefore decided that the air conditioning should be extended to the entire hospital rather than to install it for only a few rooms. In view of the fact that each individual has his own idea of what is a comfortable temperature for a room, it was decided that temperature control must be made available for each room, and that because a higher humidity is advantageous for some conditions, whereas a lower humidity is

[*Concluded on page* 47]

Setting Up a Heat Economy Program

AFTER electricity and payroll, fuel or steam for heating represents in most buildings the largest single commodity purchase; the economical purchase and utilization of heat units is therefore deserving of continuous attention.

The problem naturally divides itself into two phases; (1) the economical generation or purchase of steam, and (2) its efficient utilization. Our purpose here is to describe how to set up and carry forward a program to assure economical and efficient heating service, giving consideration to both phases.

By **Rex E. Hieronymus***

The latter phase (2) may well be called the more important for the whole heating program is put on to keep building occupants healthy and comfortable; from a strictly heating standpoint, this job must be done 100 per cent whatever the efficiency of the mechanical processes leading up to it. Acceptable performance exists only when the average temperature maintained in the occupied space during business hours is just *the* proper value—too low a temperature resulting in dissatisfaction and too high, in waste. If sub-standard temperatures are being maintained, those in charge of heating will certainly hear about it, but with overheating this is not usually the case.

To keep a continuous check on actual temperatures by means of permanent indicating or recording thermometers is often unduly expensive. To determine the trend of *average* temperatures, it is sufficient to have in the building one or more inexpensive portable recording thermometers (preferably with 3 day chart), that can be circulated continuously through the building, transfering the instrument to a different place every 24 hours. The thermometer can be placed in the custody of the

*General Superintendent, Aldis & Co., Chicago, Ill.

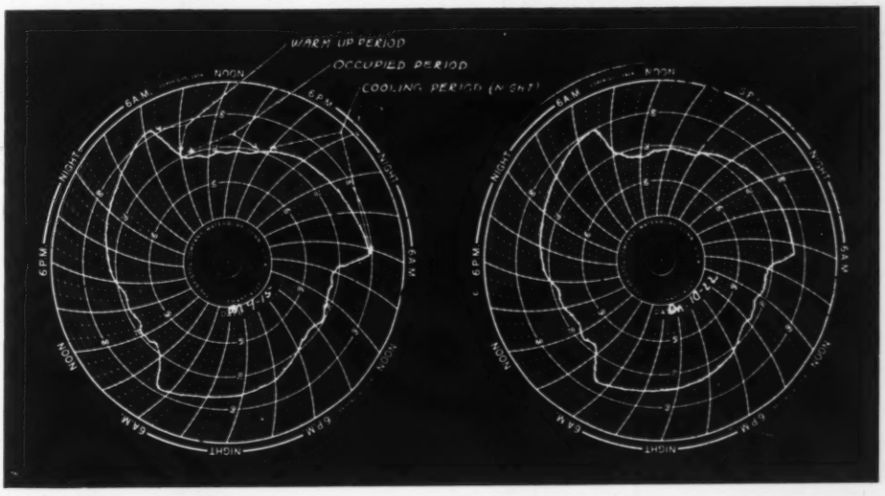


Fig. 1—Space temperatures as recorded with 3 day instrument

Such charts as these, conveniently made and at very small expense, are an excellent measuring stick of the work accomplished by the entire heating department. They are the original source of the figures used in determining average monthly space temperatures by the method illustrated in Fig. 2.

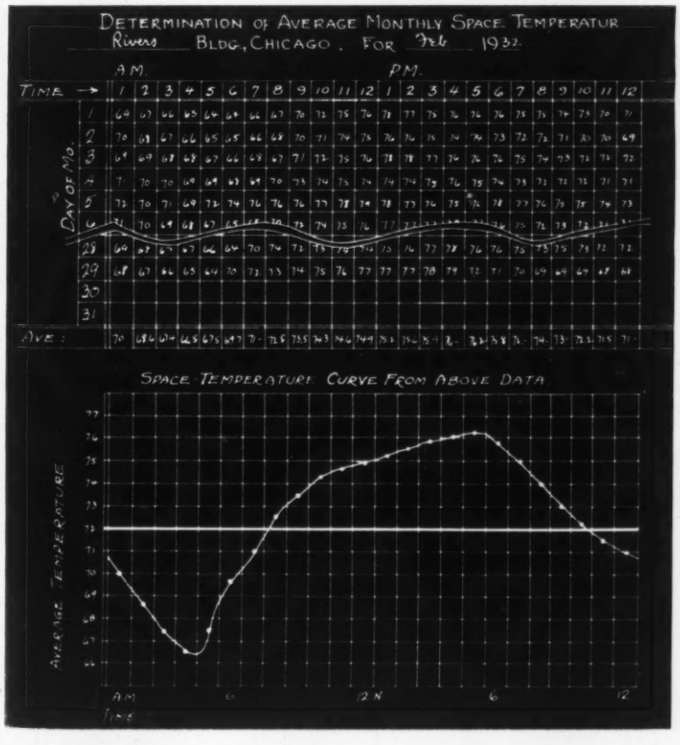


Fig. 2—Determination of average monthly space temperature

In this illustration, the top portion shows the manner of arriving at the average monthly temperature by hours. A clerk or statistician takes off the hourly temperatures from the circular charts, entering them across the sheet in the 24 spaces provided. They are then averaged vertically, and represent the average temperature in the building by hours.

The bottom half of the diagram shows the plotting of the figures produced in the upper part. The curve shown, for a building occupied from 8:30 to 6:00, reveals at once an extravagant heating condition, due primarily to (a) heat turned on too early (b) temperature at opening time higher than need be; (c) temperature gradually increasing until 5:00 p. m.; (d) occupancy temperature maintained too late in the evening; and in general, the temperature maintained too high during every hour out of the 24. This curve is the February, 1932, curve shown in Fig. 3.

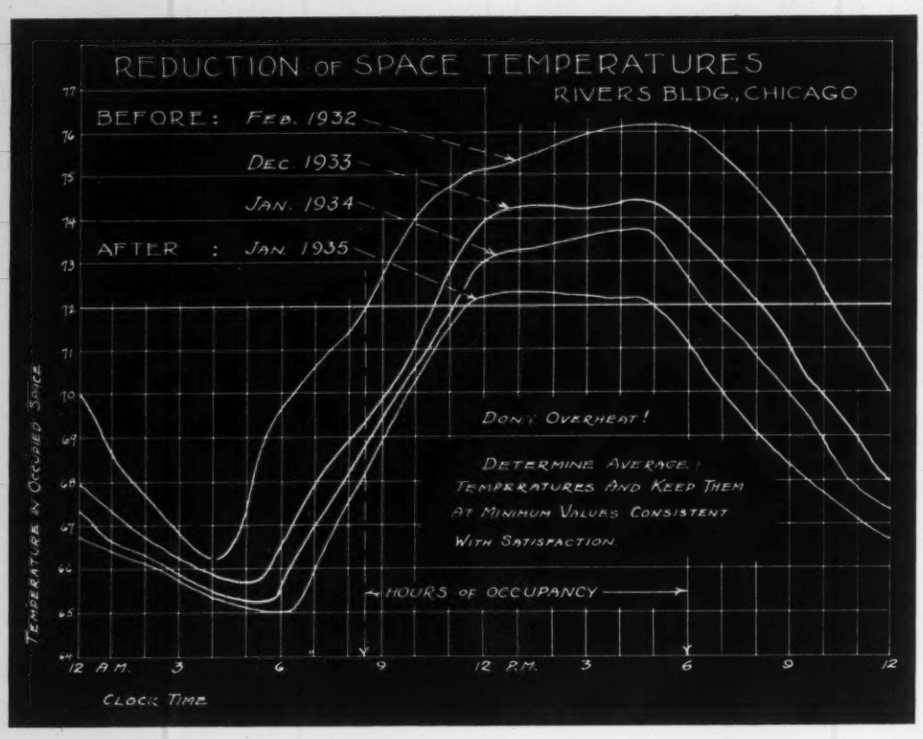


Fig. 3—Reduction of space temperatures

These curves, made by the method illustrated in Figs. 1 and 2, show the results over a short period of years of a program for heat economy. The curve for January, 1935, probably represents the minimum temperatures which will give satisfaction in this building.
During this program in this two million cu ft office building, the cost of coal for heating was reduced from 77 to 41c per degree-day. This 46 per cent reduction, amounting to $2,160 worth of fuel per year, was due partly to installation of stokers and partly to reduction of space temperatures.

watchman, who can attend to its placement and changing the chart. In the opening months of the heat economy program these charts should be inspected individually and the high and low premises can be corrected by changing the radiation. When a month's charts are assembled, have a clerk take off the hourly temperatures and average them by hours; this average temperature curve can then be plotted and its location with respect to the generally accepted minimum space temperature required for comfortable occupancy studied. Sample 3 day charts, the method of averaging the data, and representative curves obtained are illustrated.

After reasonable heating economy has been achieved, it is probably not necessary to average the temperatures for each month—very likely it will be sufficient to average one or two months each heating season, for this will furnish a check on the trend of the space temperatures. While the results of the economy program are being studied through this method, progress can also be under way toward reducing the amount of fuel required to produce the given result upstairs. All the ramifications of the heating problem should be studied simultaneously and vigorously. Don't neglect basement economy while you are getting upstairs temperature levels down to reasonable limits; investigate them both at the same time.

Daily Records are Essential

With the increasing interest in the use of the degree-day, attention is paid in most buildings at least monthly or annually to overall heating economy. However, a check at such rare intervals is totally inadequate. Only by checking steam or fuel consumption daily against the weather can the full possible economy be realized, for obviously at the end of an extravagant month, the engineer has small chance of knowing where waste occurred. If a daily check be kept, however, the engineer can reasonably be expected on Wednesday to tell what went wrong on Tuesday.

To prepare the base upon which daily performance is compared, two methods are available. One is to take the accepted economical standards for the type of building and geographical location under consideration and require the operating force to equal or improve upon this normal. With the first method, a start may be made by allowing 0.6 lb of steam per 1,000 cu ft of building volume per degree-day; or, in the absence of proper metering equipment, allow 0.1 lb of coal per 1,000 cu ft of building volume per degree-day. The other is to take the building's own previous experience (say the last full season of fuel against degree-days), establishing this or some lower figure as the standard and requiring the operators to equal it or improve upon it. If the latter method is employed, improvement will likely be easy, for nine times out of ten the practice which produces the seasonal average is composed of some very wasteful days and at least a few accidental occasional good days. As these facts become evident by the daily check, criticize the operating force for wasteful days and point out that if the building can be heated with 50,000 lb of coal on a 30 deg Thursday in November, the same can be done on a 30 deg Friday in March, other factors being equal.

Don't Be Alarmed at Occasional Complaints

To treat in detail the full list of points which need attention in a heating economy program would constitute too long an article, but they will become apparent as economy is bettered. Common sense is the watchword. Particularly is this true of such points as keeping steam shut off or regulated to a minimum for as much of the time as possible, reducing heat in vacant portions of the building, weatherstripping openings where advisable, keeping the system tight (particularly if a vacuum job), providing separate lines to sections of the building occupied at night, etc.

Most of these points and others will become apparent from the average temperature curves or the daily checks on steam or fuel consumption. Certainly with the inauguration of any program looking toward better economy,

weak spots will come to light and, as the former extravagant use of steam is cut down, complaints will come in from the low spots. The person who receives these complaints should keep a record of them, and as soon as the low spots become evident they should be corrected — probably by changes in radiation. If this is kept up, as new low spots appear, after some months a condition will be reached where complaints are not concentrated but are uniformly scattered throughout the building.

A dispassionate eye is needed in surveying building and plant heating systems and their operation to assure that maximum service at minimum cost is being obtained. "Why, we've always done it that way" is the greatest single reason a change is needed. . . . How to set up and carry forward a heat conservation program is described in detail here, supplemented with a practical discussion of the many factors involved. . . . The writer is well equipped to speak with authority, for such a program has been—and is continuing to be—carried forward in the eighteen buildings under his charge. . . . The information applies equally as well to plants as it does to commercial buildings.

Do not be alarmed at occasional complaints. They are the sign of economical dispensation of heat, for, in the total absence of complaints, you may be assured that more heat is being furnished than is needed, and therefore improvement is possible. The fine balance necessary on this particular point cannot be subjected to rule or formula, but unless the building is the best in the world and receives the highest rents, keeping in mind the frailty of the human disposition and frame, an occasional complaint from occupants is in order.

Basement Economy Obscure but Important

If the building purchases steam, there is no basement problem beyond the proper insulation of the steam lines. What follows will apply almost exclusively to a building or plant producing its own steam.

For purposes of this article, we assume a going plant and shall not treat the proper choice of boiler equipment except to say that if there is a possibility the boilers are so obsolete and inefficient that replacement is desirable, they should of course be replaced with new units. Here —as in every other phase of mechanical practice—when you need a thing you pay for it, whether you get it or not. Auxiliaries—including feedwater heaters, grates or stokers (and even furnace design), feed pumps, draft control, etc.—should be scrutinized, tested and studied, and such items as are worn out, obsolete or lacking should be replaced or installed. If the plant is high pressure, determine whether or not high pressure is really necessary; if the boilers are used only for heating, low pressure operation leads to economies.

Check Fuels on Btu per Dollar Basis

The relative values on a Btu-per-dollar basis of different available fuels should be checked, keeping an open mind on the subject of choice of fuels, for the preferred fuel may change in long cycles with market conditions. Not only initial cost of the heat units but also the cost of storing and burning them and the disposal of refuse should be given consideration.

If there are no strings tied to coal purchasing, it will pay to be hard-nosed about it. There is a great amount of hokum offered the prospective purchaser by the "strong coal" boys, who will look in your fire door and tell you your present coal is too "flashy" (terms which really have some meaning but which are greatly overworked). Return their steely look eyeball for eyeball and require them to propose not only the price per ton for which they will condescend to sell you their pet but also the approximate heating value in Btu per lb as received (not dry). Multiply this Btu figure by 2,000 and you have the heat units per ton of coal which he proposes to furnish you, say 23,500,000. Divide this figure by the net price per ton he quotes, say $4.20, and you have determined that he is offering you 56,000 Btu for

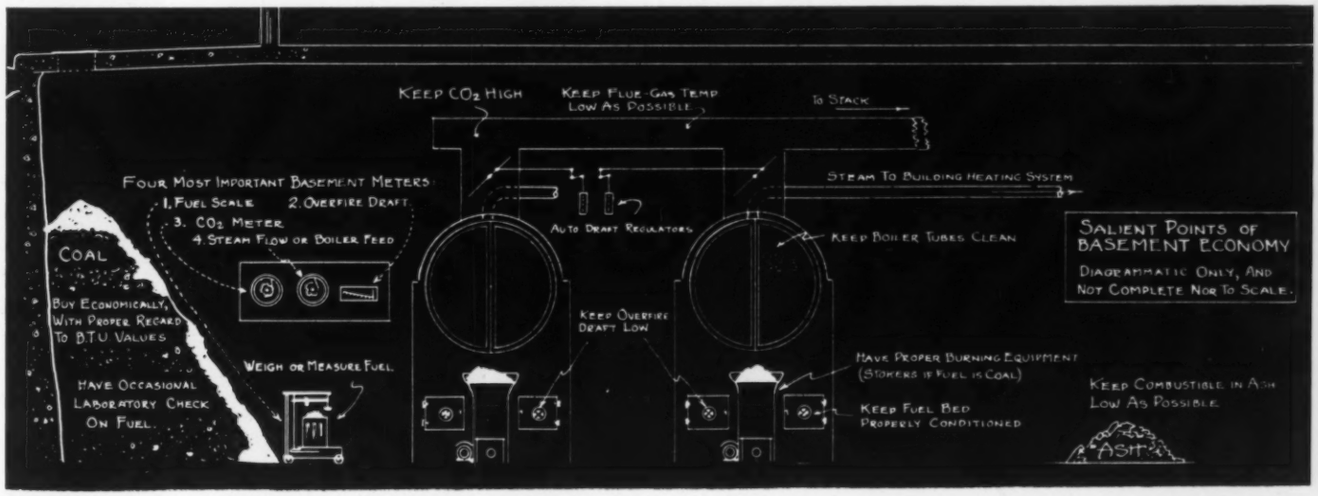

KEEP CO_2 HIGH
KEEP FLUE-GAS TEMP LOW AS POSSIBLE
TO STACK
FOUR MOST IMPORTANT BASEMENT METERS
1. FUEL SCALE 2. OVERFIRE DRAFT
3. CO_2 METER
4. STEAM FLOW OR BOILER FEED
STEAM TO BUILDING HEATING SYSTEM
AUTO DRAFT REGULATORS
KEEP BOILER TUBES CLEAN
SALIENT POINTS OF BASEMENT ECONOMY
DIAGRAMMATIC ONLY, AND NOT COMPLETE NOR TO SCALE.
COAL
BUY ECONOMICALLY, WITH PROPER REGARD TO B.T.U. VALUES
KEEP OVERFIRE DRAFT LOW
WEIGH OR MEASURE FUEL
HAVE OCCASIONAL LABORATORY CHECK ON FUEL
HAVE PROPER BURNING EQUIPMENT (STOKERS IF FUEL IS COAL)
KEEP FUEL BED PROPERLY CONDITIONED
KEEP COMBUSTIBLE IN ASH LOW AS POSSIBLE
ASH

Fig. 4—Diagram indicating the items most deserving of attention in the production of heating steam in the basement plant

one cent. Do the same with the other dealers. Then pick out the highest Btu-for-one-cent figure offered by a reliable dealer on a coal that you know you can burn, and put yourself in his hands. If it happens not to be a proved coal, have him furnish 20 or 30 tons for test, and determine whether or not it is suitable for your equipment. Under contract with him the following year, take an occasional sample from your coal bin and send it to a laboratory for a proximate analysis; if the Btu figure returned by the laboratory is within 2 or 3 per cent of his promise, there is no cause for complaint. Send him an occasional laboratory report sheet, for he will respect you the more and will be less inclined to send you an occasional consignment of inferior distress coal. Definite Btu contracts may not always prove advisable, for it will occasionally be found that the cost of frequent testing is greater over a long period of time than the adjustments obtained from the dealer, although this ratio does not necessarily prove the point, for the known schedule of testing may serve as a whip to hold the dealer in line. Certainly it is well to get the dealer's commitment as to the heating value of the coal furnished and to check his performance three or four times per year by unannounced tests.

On the proximate analysis report of the laboratory, the Btu per lb as received is the most important item. Sulphur content is important mainly for reasons of safety from spontaneous combustion while in storage. Ash is important because of firing difficulties and the relatively minor cost of ash removal. But in the main the Btu-for-one-cent system seems to be the proper method for sifting proposals.

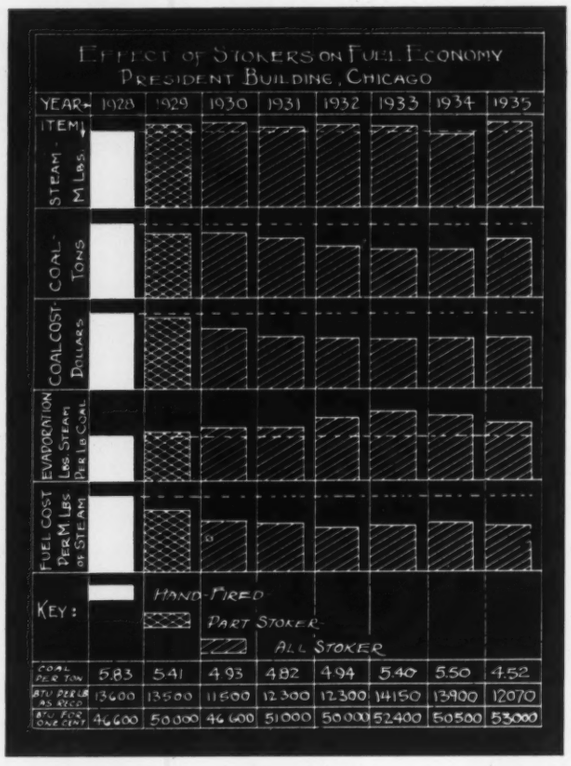


Fig. 5—Improvement in economy due to installation of stokers The 1928 quantities are shown in each case as 100 per cent, and subsequent years proportionately. Note the disparity between the different years in coal tonnage, evaporation, cost per ton, and Btu per lb as received, compared with the relative regularity of coal cost in dollars and fuel cost per 1,000 lb of steam after stoker economy was once established.

Automatic Coal Burning Equipment

It is probably safe to say that any coal burning plant consuming over 200 tons annually should be equipped with some type of mechanical stoker, for these are available in a number of types and designs, and most of the leading makes are very efficient. For annual tonnages under 200, it is my experience that a good compromise is usually found in a forced draft, hand fired combination and, considering the low investment, such equipment is desirable for small buildings.

Stokers offer several benefits. The very cheapest grades of coal can be burned and the evaporation per pound of fuel will probably exceed the previous hand fired practice on more expensive fuels. The resulting labor is less, the tonnage lower, and the unit cost lower, resulting in a three-fold economy; in addition, objectionable smoke should be virtually eliminated. There are numerous cases on record where a stoker installed in a plant burning around 750 tons of coal per boiler per year is saving its cost annually.

Disabuse yourself early, however, of the idea that a stoker is completely automatic. True, it is arranged to start and stop with variations in steam pressure or space temperature, but the best economy cannot be obtained with it unless the fireman actually treats the fire at short intervals, recomposing the fuel bed, closing the coked openings in the bed, etc., and unless the proper draft conditions are maintained.

One point should be made about stoker programs. Full improvement is probably not obtained in the first year of operation. In our experience, covering a number of installations, the maximum yearly improvement occurs during the first year and the final improvement seems to occur in the fourth year. Consequently, active supervision of the stoker operation needs to be exercised for that length of time.

The cost of the electricity required to operate the stoker is usually not given consideration, for it is not of much consequence when compared to the possible savings attendant upon its use. From tests covering a number of stoker installations (sizes ranging from 50 to 1,200 lb per hr) it has been found that from 5 to 9 kwhr are required to burn each ton of coal. The cost of this electricity, although noticeable, should not be discouraging, for there are cases where fuel cost for steam may be reduced from 55c per 1,000 lb of steam to 35c, solely due to the installation of stokers, and to get this 36.4 per cent reduction, it is necessary to buy only ½ kwhr of electricity. (This figure is arrived at as follows: Assume an average consumption of 7 kwhr per ton of coal, and an evaporation of 7 lb of steam per lb of coal. One ton of coal will generate 14,000 lb of steam. Therefore the consumption of electricity is ½ kwhr per 1,000 lb of steam.)

Draft Control—The subject of proper draft can best be covered by saying that automatic apparatus should be installed to limit the draft over the stoker fire to the very minimum value that will still carry the smoke and gas up the chimney instead of blowing it out through the openings in the boiler front. Standard units are available from reliable manufacturers and it is not un-

common for them to guarantee their draft control to accomplish savings of 10 or 15 per cent. Although intrinsically expensive, they will usually pay for themselves within a year's operation.

Don't Overlook Instruments

There may be some plant which has too many instruments, but for every such there must be a thousand whose complement of instruments is inadequate.

Fuel—Some method of measuring the fuel used daily is indispensable. Fuel oil can be metered or gauged. Coal can be weighed, which in a large plant should be done on automatic weigh larries, but in small plants may be measured by a monorail scale or by the wheelbarrow load over a platform scale. In many cases it is sufficient to keep track of coal by volume. You can get from your coal dealer, or determine for yourself, the lb per cu ft for the particular fuel you are using, and have your fireman measure the coal as fired in a home-made box of known dimensions which he will fill and screed off, this method being much simpler than weighing out the coal correctly to the pound. If stokers of the ram or screw type are used, it may be adequate to put counters on the stoker, developing by test the proper factor of pounds per stroke or per revolution, whereafter the daily record can be kept by the stoker count and reconciled with the bin and delivery inventory at the end of each month. Fuel should be so measured, regardless of whether or not steam flow meters are used. Don't hesitate to require your boiler room crew to weigh the coal. This practice will have a beneficial effect, even though you never look at the results.

Steam and Feedwater—Steam flow meters or boiler feedwater meters are not strictly necessary where steam is neither sold nor bought outside the building and where fuel is used only for heat. Equally economical performance may be obtained without them through other methods. However, in the larger plants (where fuel consumption exceeds 750 tons per year) they probably should be installed. Steam flow meters for low pressure work are notoriously inaccurate, and in a low pressure plant the water fed to the boilers should be measured instead. These quantities may be taken as steam production, and blow-down and losses ignored providing the steam is used only for heating.

Where steam or feedwater meters are used, the daily heating performance record should be kept in terms of steam used, but the fuel should still be weighed and the daily evaporation kept in chart form. By this means the supervisor can check not only the efficiency of the upstairs utilization of the heating steam but can also check the efficiency of the boiler room operation in producing it. This double check facilitates the attainment of all-round economy.

Flue Gas—The CO_2 content of the flue gas is an extremely useful yardstick for checking probable boiler economy and if only one point of basement operation were to be emphasized it should be this—to maintain the highest possible CO_2 at all times in the flue gas. The high loss attendant upon low CO_2 conditions is indicated in the accompanying chart, and every engineer should realize these relationships and have means at his disposal for determining CO_2 at least occasionally if not continuously.

Recording CO_2 meters are rather expensive, but any plant using 1,000 tons of coal per year, or perhaps even much less than this, should have at least one recording CO_2 meter which may be manifolded and used on different boilers alternately. In a plant having several boilers, it probably is not necessary to have one recording CO_2 meter on each boiler. If the purchasing agent (or the vice-president) vetoes the recording instrument, slip past him with a requisition for a hand Orsat flue gas machine and require its use periodically. It will show what firing conditions produce high CO_2.

The minor instruments, chiefly thermometers and pressure gauges, should be installed wherever there is the slightest indication that they are needed, because an inexpensive thermometer or gauge doesn't have to do much to justify its cost.

If You Need New Equipment, You're Paying for It

In view of the great amount of free consultation and advice available from manufacturers and purveyors of equipment through their highly trained corps of sales engineers, it is hard to understand how some building and plant engineers can persist in obsolete, wasteful practices. Very likely part of the explanation lies in the fact that there is chaff with the wheat among some sales emissaries, and on the average their assurances to the prospective purchaser are probably over-optimistic. An engineer who has been badly disappointed by one extravagant claim is likely to view with suspicion all succeeding presentations. Mechanical practice, however, is a rapidly changing field and a good engineer will look into the merits of proposed improvements and at the expense of occasional mistakes, which all of us should be entitled to make, will pick the good from the bad and keep abreast of the times, the management being willing. Certainly there comes a time with every piece of mechanical equipment where the old horse has to be plowed under and forgotten and the new putt-putt put to work.

The sensible engineer is often over-ruled by a non-technical supervisor who wants to continue operating the old apparatus at a loss "until we get our money back." This point of view resembles most nearly the stock market operator who in a disrupted security market sells the good work horses and keeps the cats and dogs, hoping they will come back, and because they have further to come back, when the exact opposite should be done, *i. e.*, chuck the cats and dogs and keep the substantials. Fortunate indeed is the engineer who has developed the ability to determine the actual needs of the boiler room and the building and whose management will approve the expenditures for the equipment needed. The old maxim should here be re-emphasized: *When you need a thing, you pay for it whether you get it or not,* and therefore, quite logically, since you are going to pay for it anyway, you might just as well have it and enjoy the benefits.

High Points of One Economy Program

During the bright years of the middle 1920's, central station practice attained new heights of magnitude, reliability and economy in a great upswing of temperature, pressure and size of units, both boilers and electric gen-

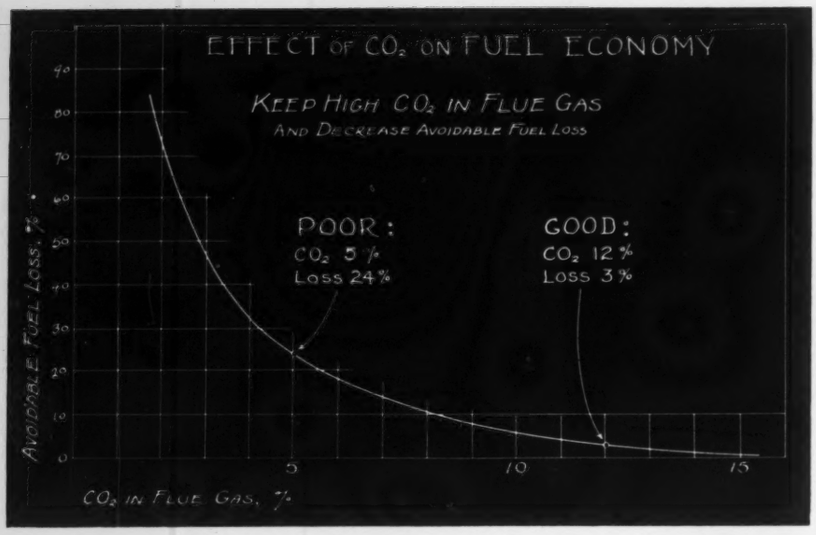


Fig. 6—Effect of CO_2 on fuel economy In a boiler which is in poor condition and operated by an incompetent fireman, it is not uncommon to find CO_2 as low as 3 or 4 per cent. A good fireman on almost any kind of a boiler can maintain at least 10 per cent CO_2. Note from the curve what this improvement would mean in terms of savings.

erating equipment. The same progress, although to a less spectacular degree, occurred simultaneously through the whole equipment field affecting the operation of plants and buildings. Boilers, furnaces, stokers, draft control, pressure and temperature control, and lesser related items were greatly improved, rendering much of this equipment obsolete and making obsolescence more noticeable. With the ledger upsets growing out of the long-continued depression, there came about a greater need for economy in every avenue of operation, and here was the better apparatus with which to accomplish an improvement now needed more sorely than ever.

Suiting the action to the need, the author's firm began in 1929 a complete and dispassionate review of all existing practices in the seven buildings which they actively managed at that time, with the two-fold object of improving service where possible and of reducing the cost thereof if possible.[8] Because of its important place in the ledger accounts, the heating department came in for prompt action for each of the buildings then in the agency, and subsequently for each additional building as it came to their management. Many changes and improvements have been made, too numerous and too complicated to tabulate here, but in general each of the improvements is touched upon somewhere in the foregoing paragraphs.

The capital cost of the improvements has aggregated some $36,000 and the annual operating costs have been decreased by more than this amount. The major capital expenditure went for new equipment not strictly necessary in order to keep the buildings warm but which was definitely needed and is self-liquidating and profitable. A small part of this sum went toward the replacement of minor apparatus which, aside from considerations of economy, had become difficult to operate on account of old age. As the high points in this program, the following items may be mentioned as having been adequately accomplished or set in motion in eighteen buildings:

1. The proper turning-on-and-off schedule of each building has been determined and put into effect.
2. A system of checking degree-day performance has been installed with adequate daily records to insure continuous good performance in each building.
3. In buildings where the tonnage justifies it, continuous record is kept of the evaporation per pound of coal.
4. Space temperature curves have been used in the development of economy and will continue to be used in buildings where this form of check is necessary.
5. The boiler plants in five buildings have been changed from high to low pressure.
6. The sole remaining electric light plant has been shut down at a profit to the building.
7. An unprofitable contract for the purchase of steam was cancelled on payment of penalty, the capacity of the existing plant having been increased by stokers to take care of the requirements formerly purchased.
8. Fifteen stokers have been installed.
9. One oil burning plant has been taken out of service and replaced by stoker firing, a study showing this advisable in this case.
10. Space temperature regulating systems have been installed in four buildings.
11. Proper schedules for cleaning boiler tubes have been inaugurated for each building.
12. Eleven automatic damper equipments have been installed.
13. Miscellaneous obsolete steam pumping equipment has been replaced with electric pumps.
14. Ten additional meters to record steam flow or water fed to boilers have been installed.
15. One additional recording CO_2 meter has been installed and several hand Orsats provided.
16. An undetermined number of miscellaneous thermometers, pressure gauges, and thermostats have been installed.
17. In all except the smallest buildings one or more portable recording thermometers have been installed and are used continuously through the heating season.
18. An undetermined quantity of obsolete or ineffective cast iron radiation has been replaced with new cast iron radiation, fin type convectors, or blast unit heaters.
19. An undetermined number of "low spots" in the different buildings have been brought up to standard and a number of unnecessary radiators removed from premises formerly overheated.
20. Several special lines have been run to 24 hr premises.
21. In several buildings not already so arranged, the first floor (store) radiation has been connected to a special line divorced from the upstairs heating.
22. Automatic temperature control has been installed on the service water heating systems of several buildings, and several separate fired service water heating systems have been converted to steam heat for the winter season when the heating boiler is in operation.
23. One additional gas fired service water heater for summer use has been installed.
24. Attempt has been made in every way except by formal classes to increase the knowledge and ability of each engineer and fireman.

Each building must be studied with a continuously open mind, and it should be remembered that when it is said of any practice or mode of operation, "Why, we've always done it that way," this is the greatest single reason a change is needed.

Heating · Piping and Air Conditioning's ANNUAL AIR CONDITIONING REVIEW

[Number of air conditioning installations and connected horsepower for 1935, 1936 and totals as of December 1, 1936; estimated increases this year; number of air conditioned railroad cars and types of systems]

MATERIAL increases in summer air conditioning activity this year over last are estimated throughout the country, with commercial applications continuing to lead. Table 1 summarizes the opinions of the utilities in various cities on what 1937 will mean as compared to 1936, and the types of buildings which will lead in air conditioning in 1937. Few of the estimates run lower than 25 per cent; many of them exceed that figure greatly, one being 500 per cent. In Chicago—a leading "air conditioning city"—the limit of air conditioning business will be found in the man power of the industry, it is predicted.

Table 2 summarizes the number of installations and connected horsepower for air conditioning commercial and institutional buildings, industrial plants, and residences in cities and towns having a total population of over 30,000,000. Figures are shown for 1935 installations, 11 months of 1936, and totals as of Dec. 1, 1936 (See pages 32 and 33).

Using Loran D. Gayton's method of calculating the percentage a district is air conditioned as described in a paper published in the November, 1936, H. P. & A. C., it is seen that anything like an approach to "100 per cent" is still very much in the offing. (If there were air conditioned space in a district for each of the persons in that district we might say that the district was 100 per cent air conditioned, stated Mr. Gayton. To furnish an air conditioned space for one person requires an average heat removal of 2300 Btu per hr, whereas a ton of refrigeration is equivalent to 12,000 Btu per hr. Therefore, 5.2 persons may be accommodated with air conditioned space by each ton of refrigeration. A survey of installations totalling 17,433 tons capacity indicated the

[*Concluded on page* 38]

Table 1—Estimated Increase in Air Conditioning in 1937 Over 1936 and Types of Buildings Which Will Probably Lead in Air Conditioning in 1937

ALABAMA	
Birmingham	20% in hp, no. of jobs same. Dept. stores and specialty shops.
CALIFORNIA	
Los Angeles	Commercial.
San Diego	20%. Stores.
COLORADO	
(See footnote, Table 2)	200%. Commercial.
CONNECTICUT	
Hartford	Dept. stores.
DISTRICT OF COLUMBIA	
Washington	No. will be approximately the same, with total capacity slightly increased. Capacity increase approximately 5% (low as governmental jobs will decrease slightly). Hotels and office buildings will lead in capacity.
FLORIDA	
Fifteen towns (see footnote)	30%. Commercial.
ILLINOIS	
Chicago	40%, both no. and hp. Office & commercial bldgs, retail stores.
Rockford	100%. Residential.
INDIANA	
Indianapolis (and Marion Co.)	100%. Residential, private offices, general offices.
IOWA	
Cedar Rapids	50%. Small stores and shops.
Des Moines	Misc. commercial, residences.
KENTUCKY	
Louisville	150%. Dept. stores.
MASSACHUSETTS	
Boston	100%. Office buildings.
Springfield	100%. Commercial establishments.
MICHIGAN	
Detroit	150%. Commercial.
Grand Rapids, Jackson, Flint, Kalamazoo and others (see footnote)	50%.
MISSISSIPPI	
Jackson and others (see footnote)	100-150%.
MISSOURI	
Kansas City	Dept. stores.
St. Louis	"Material increase."
NEBRASKA	
Omaha	25%. Office buildings.
NEW YORK	
New York City	
Brooklyn	No increase. Small retail stores will lead.
Queens	Commercial jobs will exceed 1936.
Rochester	Industrial.
Watertown	300%. Restaurants.
Western New York (see footnote)	Small stores, offices, neighborhood theaters.
OHIO	
Cincinnati	25%. Commercial.
Toledo	25%. Dept. stores.
OKLAHOMA	
(See footnote, Table 2)	100%. Commercial, residential.
PENNSYLVANIA	
Johnstown	150%. Chain stores and theaters.
Philadelphia	100%. Dept. stores.
RHODE ISLAND	
Providence	10%.
SOUTH CAROLINA	
Charleston	25%. Chain stores and professional offices.
Columbia	Possibly no increase in number, but double capacity. Theaters and stores.
TENNESSEE	
Chattanooga	50%. Commercial.
Knoxville	133%. Retail stores.
TEXAS	
Beaumont and Pt. Arthur	No. will increase, but not horsepower. Restaurants and drug stores.
El Paso	500%. Dept. stores, hotels.
San Antonio	30%. Dept. stores, hotels.
WASHINGTON	
Spokane	100%. Restaurants.
WISCONSIN	
Six towns (see footnote)	Will increase. Restaurants and taverns.

Table 2—Number of Air Conditioning Installations and Connected Horsepower for Air Conditioning for Commercial and Institutional Buildings, Industrial Plants, and Residences for 1935, 1936, and Totals to Dec. 1, 1936

Area	1935								1936 (11 months)								Total as of Dec. 1, 1936 (Including prior to 1935, 1935 and 1936)								Approx. Population of Area
	All Bldgs.		Com. & Inst.		Ind.		Res.		All Bldgs.		Com. & Inst.		Ind.		Res.		All Bldgs.		Com. & Inst.		Ind.		Res.		
	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	No.	Hp	
ALABAMA																									
†Birmingham	22	951	19	946.4	..	...	3	4.6	47	583	36	511	1	20	10	52	93	2380	73	2263	2	22.5	18	94.5	300,000
CALIFORNIA																									
So. Calif. Edison Co.	56	833	21	50	29	768	6	15	68	1597	45	846	14	731	9	20	*..	*...	*...	*...	*..	*...	*..	*..	1,250,000
San Diego	3	165	1	7	2	158	..	...	2	64	2	64	..	..	..	..	5	415	3	257	2	158	..	..	180,000
COLORADO																									
Five towns (see footnote)	5	41.5	4	34.5	1	7	..	...	4	20	4	20	..	..	..	..	21	141.5	20	134.5	1	7	..	..	60,000
CONNECTICUT																									
Hartford	14	191	13	190	..	...	1	1	13	331	12	328	..	..	1	3	41	1353	35	1212	3	135	3	6	247,000
DIST. OF COLUMBIA																									
Washington	159	8634	123	8551.25	..	...	36	82.75	132	8974	122	8965	..	..	10	9	460	33,496.25	382	33,195	8	156	70	145.25	619,000
FLORIDA																									
Fifteen towns (see footnote)	52	998	39	969.9	..	...	13	28.1	70	923.9	53	879.3	4	9.6	13	35	146	2891.3	115	2807.5	4	9.6	27	74.2	363,000
††St. Petersburg	..	...	4	18	..	...	..	...	..	....	3	45	..	..	..	..	..	...	7	63	..	...	..	..	45,000
ILLINOIS																									
†Chicago	317	5462	273	4936.5	20	499.25	24	26.25	417	7588	347	6918.75	23	630	47	39.25	1351	56,530	1113	48,662.5	123	7729.5	115	138	3,500,000
†Rockford	8	61	5	48	1	10	2	3	15	64.3	5	45.3	..	..	10	19	23	125.3	10	93.3	1	10	12	22	85,000
INDIANA																									
†Indianapolis (and Marion County)	46	1480	33	1442.5	1	5.5	12	32	89	821.16	57	730.66	3	54.75	29	35.75	174	4451.91	118	3887.66	6	476	50	88.25	425,000
IOWA																									
Cedar Rapids	15	139	9	123.75	1	2	5	13.25	15	201.75	14	195.25	..	..	1	6.5	*..	*...	*...	*...	*..	*...	*..	*..	56,000
Des Moines	39	422	35	416.5	..	...	4	5.5	73	2332.84	55	2310.51	1	1	17	21.33	168	3641.8	133	3551.96	3	38.5	32	51.33	150,000
KENTUCKY																									
Louisville	35	713.25	30	692.25	1	20	4	1	40	530.16	31	415.33	8	111.5	1	3.33	125	2574.4	96	2087.4	14	453	15	34	350,000
MARYLAND																									
Baltimore	*	*	*	*	*	*	*	*	108	1635.5	96	1589	2	9.5	10	37	342	9620.5	303	8933	13	613.5	26	74	1,130,000
MASSACHUSETTS																									
Boston	57	1851.5	48	1540	4	299	5	12.5	81	1892.6	74	1820	4	70	3	2.6	227	10,747.6	203	10,274.5	10	414	14	59.1	1,394,000
Springfield	15	274	14	272.5	..	...	1	1.5	21	178.5	16	111	2	63	3	4.5	44	747	37	673	2	63	5	11	150,000
MICHIGAN																									
† ††Detroit	88	4398	61	2867	13	1505	14	26	228	2058	118	1920	5	24	105	114	504	18,354	322	15,782	29	2351	153	221	2,436,000
†Grand Rapids, Jackson, Flint, Kalamazoo and others (see footnote)	51	386.3	34	256.4	6	120.25	11	9.65	57	473.45	50	448.5	1	20	6	4.95	*..	*...	*...	*...	*..	*...	*..	*..	950,000
MISSISSIPPI																									
Jackson and others (see footnote)	18	99.5	12	92.25	1	5	5	2.25	45	194.75	33	180.5	1	1.5	11	12.75	*..	*...	*...	*...	*..	*...	*..	*..	264,000
MISSOURI																									
†Kansas City	120	3727	82	3604	..	...	38	123	229	2206.75	134	2029	..	..	95	177.75	*..	*...	*...	*...	*..	*...	*..	*..	425,000
†St. Louis	187	5344.21	106	4713.44	13	485.85	68	144.92	431	6889.23	226	6139.13	11	436.65	194	313.45	939	21,048.28	505	18,195.68	44	2107.43	390	745.17	1,250,000
NEBRASKA																									
Omaha	45	1133	..	...	..	...	..	...	83	1416.5	..	..	..	..	..	..	183	3963	...	...	..	...	..	..	220,000
NEW HAMPSHIRE																									
Manchester and others (see footnote)	11	56.25	5	54.75	2	0.75	4	0.75	20	59.75	4	33.75	1	22	15	4	37	142.45	11	110.2	4	26.75	22	5.5	186,000
NEW YORK																									
New York City																									
Brooklyn	65	2614.72	52	2280.77	5	325.05	8	8.9	52	2508.2	49	2498.1	3	10.1	..	..	192	12,830	158	11,940.75	23	869.35	11	19.9	2,700,000
Manhattan and Bronx	210	8255.34	200	8191.29	6	53.75	4	10.3	241	7836.61	218	7387.25	18	429.03	5	20.33	*..	*...	*...	*...	*..	*...	*..	*..	3,132,000
†Queens	15	218.35	13	178.6	1	36.25	1	3.5	28	704.75	25	671	3	33.75	..	..	87	5973	60	4109.85	14	1837.75	13	25.4	968,000
Rochester	*..	*...	*..	*...	*..	*...	*..	*..	38	1701	23	415.5	5	1268	10	17.5	92	26,688	55	3028	16	23,621.25	21	38.75	469,000

†Syracuse	*..	*...	*..	*...	*..	*...	*..	*..	141	319.25	16	251	2	22.5	123	45.75	341	1750.25	33	1334.5	6	308	302	107.75	250,000
††Watertown	2	6	..	...	2	6	..	...	1	15	1	15	..	..	..	..	*..	*...	*...	*...	*..	*...	*..	*..	35,000
Western New York (see footnote)	4	362.5	3	212.5	1	150	..	...	44	1692	39	1686.5	..	..	5	5.5	48	2054.5	42	1899	1	150	5	5.5	875,000
OHIO																									
Cincinnati	96	2505	64	2457.5	..	...	32	47.5	172	1693	102	1592.25	..	..	70	100.75	417	9679.25	276	9468.75	†..	†..	141	210.5	600,000
†Toledo	26	490	19	386	5	100	2	4	47	1201	40	1075	3	120	4	6	97	3159	73	2711	10	425	14	23	300,000
OKLAHOMA																									
Oklahoma Gas and Elec. Co. System	55	844.37	33	798.93	1	3.3	21	42.14	160	1530	90	1412.25	1	3.5	69	114.25	291	3966.93	157	3705.71	4	21.25	130	239.97	591,000
PENNSYLVANIA																									
Johnstown	*..	*...	4	44.5	*..	*...	*..	*..	*..	*..	4	23.75	*..	*..	*..	*..	*..	*...	8	68.25	*..	*...	*..	*..	170,000
Philadelphia	120	5154	72	4234	22	844	26	76	176	4198.62	132	3301.15	11	841	33	56.47	586	26,164.62	388	20,502.15	94	5461	104	201.47	2,754,000
Pittsburgh	92	1412.5	63	1314.5	4	65	25	33	113	2319.5	84	2245.25	4	33.5	25	40.75	297	7912.5	222	7202.5	12	621.5	63	88.5	1,400,000
RHODE ISLAND																									
Providence	8	103.8	6	98.8	..	...	2	5	20	348	17	344	..	..	3	4	41	1188	36	1179	..	...	5	9	300,000
SOUTH CAROLINA																									
Charleston	1	13	1	13	..	...	..	...	2	134.5	2	134.5	..	..	..	..	3	147.5	3	147.5	..	...	..	..	63,000
Columbia	3	604	3	604	..	...	..	...	6	92	6	92	..	..	..	..	7	696	7	696	..	...	...	..	52,000
TENNESSEE																									
Chattanooga	42	524.95	41	524.45	..	...	1	0.5	57	965.28	44	949.2	..	..	13	16.08	146	2611.33	115	2566.65	..	...	31	44.68	500,000
Knoxville	6	62.75	4	60.25	..	...	2	2.5	8	690	8	690	..	..	..	..	17	1129.75	15	1127.25	..	...	2	2.5	115,000
TEXAS																									
Beaumont and Port Arthur	9	245	7	238	..	...	2	7	13	848	11	798	..	..	2	50	29	1408	*...	*...	*..	*...	*..	*..	115,000
El Paso	13	170	9	164	..	...	4	6	15	148	13	144	..	..	2	4	*..	*...	*...	*...	*..	*...	*..	*..	100,000
San Antonio	30	996.5	21	922.25	2	67.25	7	7	38	856.1	26	831.6	..	..	12	24.5	117	6382.1	80	6253.35	2	67.25	35	61.5	254,000
VIRGINIA																									
Richmond, Norfolk and others (see footnote)	74	1867	60	1777	3	65	11	25	60	1273	48	1204	3	50	9	19	181	6496	137	5719	9	700	35	77	.....
WASHINGTON																									
Spokane	*..	*...	*..	*...	*..	*...	*..	*..	7	64	6	63	..	..	1	1	*..	*...	*...	*...	*..	*...	*..	*..	120,000
WISCONSIN																									
Milwaukee	*..	*...	*..	*...	*..	*...	*..	*..	22	612.44	22	612.44	..	..	..	..	*..	*...	*...	*...	*..	*...	*..	*..	578,000
Six towns (see footnote)	5	199	5	199	..	...	..	...	7	35	6	20	1	15	..	..	12	234	11	219	1	15	..	..	375,000

Footnotes, Table 2

*No data available or records incomplete.

†Figures do not include installations not connected to utility's lines unless marked (†).

††Figures include connected hp for fans and pumps unless marked (††).

California, Southern California Edison Co.—Approximate capacity of installations not having electric driven refrigerating machines is 75 tons.

Colorado—Figures given cover Canon City, Florence, Rocky Ford, La Junta and Pueblo.

District of Columbia, Washington—Of the installations listed in the column "Commercial and Institutional," the following are in governmental buildings—1935—21 installations, 4898.75 hp; 1936—5 installations, 4403 hp; total as of Dec. 1, 1936—62 installations, 19,721 hp.

Florida—Figures cover the following: Miami, Miami Beach, Ft. Lauderdale, Coral Gables, West Palm Beach, Melbourne, Daytona Beach, Hollywood, St. Augustine, Lake City, Arcadia, Bradenton, Sarasota, Hastings, and Sanford.

Illinois, Chicago—Jobs not having electric driven refrigerating machines total approximately 1650 tons capacity.

Illinois, Rockford—Approximate capacity of installations that do not have electric driven refrigerating machines is 23 tons.

Indiana, Indianapolis and Marion County—Horsepower of installations without electric driven refrigeration machines is 513¼ hp.

Iowa, Des Moines—Figures include ice jobs totalling 43 tons. Five washer jobs not included.

Kentucky, Louisville—Figures include many well water systems; tonnage unknown. Also, they include two steam jet jobs (tonnage 155) and one silica gel job (tonnage 12.75).

Maryland, Baltimore—Total figures include steam jet installations of 345 tons and silica gel or similar adsorption systems of 210 tons latent heat removal capacity.

Michigan, Detroit—Figures include steam jet jobs totalling 181 tons, ice and well water jobs of unknown tonnage.

Michigan; Grand Rapids, Jackson, Flint, Kalamazoo, and others—Belding, Greenville, Clare, Battle Creek, Bay City, Flint, Grand Rapids, Jackson, Kalamazoo, Lake Lansing, Charlotte, Muskegon, Saginaw, Alma, Allegan, Pontiac. 1936 figures include 21 well water or cold city water jobs totalling 983 tons. 1935 figures include 23 well water or cold city water jobs totalling 581 tons.

Mississippi; Jackson and others—Jackson, Drew, Lexington, Moorhead, Grenada, Winona, Magnolia, Natchez, Ruleville, Cottondale, Holly Knowe, Greenville, Vicksburg, McComb, Cleveland, and Brookhaven.

Missouri, Kansas City—Approximate capacity of steam jet installations, 300 tons.

Missouri, St. Louis—Figures include jobs without electric driven refrigerating machines totalling 1500 tons capacity.

New Hampshire, Manchester and others—Manchester, Dover, Laconia, Bedford, Nashua, New London, Littleton, Portsmouth, Derry, and Concord.

New York City, Brooklyn—1935 figures include one evaporative cooling job with 10 hp and 11 well water jobs with 243 hp; 1936 figures include 15 well water jobs with 605.75 hp.

New York City, Queens—Figures include jobs with well water refrigeration totalling about 300 tons capacity.

New York, Rochester—There is approximately 22,500 hp where customers generate part of their power requirements and purchase rest from utility. There is no way of knowing accurately percentage purchased from utility, but it is estimated that approximately 50 per cent is purchased; varies considerably depending upon need of exhaust steam in process and whether turbo-generators are down for repairs. As to expected capacity for 1937, the film industry in Rochester represents such an enormous block of air conditioning that any forecast for expected additions can be thrown into the discard if they happen to decide to "make a small addition."

New York, Syracuse—1936 residential installations comprise 2 year 'round jobs with 3.75 connected hp, and 121 winter conditioning jobs totalling 42 connected hp. Total residential jobs to date comprise 2 installations with 3.75 hp for year 'round conditioning, 300 installations totalling 104 hp for winter conditioning.

New York (Western New York)—Figures do not include jobs with which utility has had no contact and are therefore incomplete, particularly industrial and residential installations. For instance, there is in Buffalo one plant alone which has over 6500 hp for air conditioning and is not included in table.

Ohio, Toledo—Figures include one 20 hp and one 145 hp installation not on utility's lines. Approximate capacity of well water installations in this area is 400 tons.

Oklahoma (Oklahoma Gas and Electric Company's System)—There are *also* 137 evaporative cooling installations in the territory these figures cover totalling 1284.25 hp.

Pennsylvania, Johnstown—Figures include one job with 25 connected hp not having electric driven refrigerating machine.

Pennsylvania, Pittsburgh—Several installations combine well water and mechanical refrigeration.

Texas, Beaumont—The large figure of 50 hp for residential installations is made up of one 12 hp job and one 38 hp job. The latter is in a $150,000 residence, one 15 hp compressor being required for the lower floor and another for the second floor. Six hp is required for the two fans and 2 hp for the water circulating pump.

Texas, El Paso—Approximately 50 per cent of the installations covered by the figures given do not have electric driven refrigerating machines.

Virginia, Richmond, Norfolk, and others—Figures represent totals for Virginia Electric and Power Co.'s entire territory in eastern Virginia and northeastern North Carolina, although the majority of installations have been made in the two largest cities, Richmond and Norfolk.

Washington, Spokane—Figures include 1 evaporative cooling installation with 13 connected hp.

Wisconsin (six towns—Green Bay, Oshkosh, Sheboygan, Marinette, Menominee, Wausau, and contingent territory. 35 hp of water cooling jobs included.

New Method of Studying Erosion Aids Selection of Valve Seat Materials

By Fred R. Venton*

Described here is an accelerated test method developed for determining the relative resistances of various commonly used metals for valve seat service to the particular type of erosion known as "wire drawing." A number of photomicrographs of test specimens are reproduced . . . The author includes a discussion of the factors to be considered in the selection of valve seating materials, and presents some of the results of the studies which have been conducted.

EROSION of parts in service is one of the prime limiting factors to be considered with respect to the probable useful service life of a valve and yet, until quite recently, no serious effort was made to classify metals experimentally as to erosion resistance.

Satisfactory techniques have been developed and adopted generally for the determination of other known factors contributing to the adaptability of a metal for valve seat service. For example, a rapid indication of the tendency for electrolytic action to occur and an approximation of the rate at which the deterioration of the attacked metal will proceed can be obtained by suspending small specimens of the two dissimilar metals in question in a suitable electrolyte and measuring the voltage and current produced by the battery thus formed. Due to the number of investigations and the long period of time over which corrosion studies have been conducted, there is a wealth of such information available to the engineer. The determination of the ability of metals to resist the seizing and tearing (commonly referred to as "galling") that is likely to occur when two metal parts are held in contact under high loads and drawn across one another without suitable lubrication is approached in two ways. In the laboratory, specimens of various metals are rubbed together by means of a special wear testing machine. The bearing loads are accurately predetermined and the classification of the metals is accomplished by noting the number of strokes to cause seizure, the weight loss of the specimens, and the general appearance of the surfaces. A test of this type under actual working conditions is readily achieved by fitting a gate valve with disc and body seat facings of the desired metal combination and operating the valve on steam pressure, allowing the outlet to exhaust to atmosphere. In these methods the wear resistance of metal combinations with respect to valve service has been well investigated and considerable data are available. The thermal expansion properties and the general safe temperature limitations of the more commonly used materials are quite well established and "creep" tests have been devised to measure the effect of combined stress and temperature conditions with their resultant plastic deformation of the metals.

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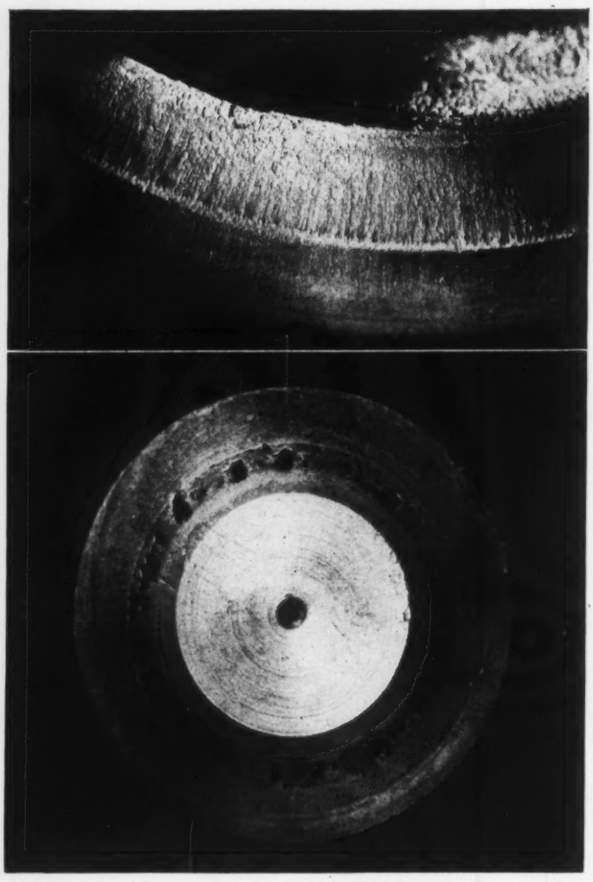
Earlier Test Methods

Earlier attempts, however, to duplicate in test laboratories the severe erosion of valve parts encountered in some particular services were largely ineffective and of a hit or miss nature.

In these early efforts at determination of erosion resistance complete globe valves were made up with body seats and discs of the desired materials. Numbers of these special valves were installed on the outlet ports of high pressure steam headers and an attempt was made to keep the discs of all the valves just cracked away from their respective seats an equal distance. Regardless of how accurately the valves were set at the start of the test, the amount of seat opening of the different valves varied and a man's time was required constantly to maintain the proper settings. For this reason, and because the average test period required to show results ran into months or even years, valve erosion tests were



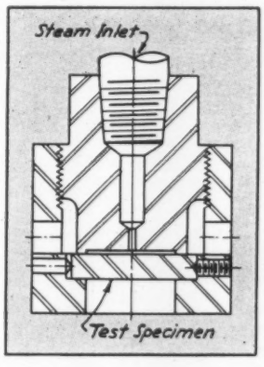
Top—Section of nitrided gate valve disc eroded in service. *Bottom*—Brass globe valve disc eroded on hydraulic throttling service

reluctantly undertaken and rarely progressed to a satisfactory conclusion.

Acceleration of such tests to the point that reliable results might be realized before interest in the job had died was attempted by introducing different abrasives into the path of the fluid flowing to the test header. This effort did not work out satisfactorily because of a tendency of the abrasives either to settle out or to pile up at the valve seats, shutting off the flow through the valves.

Better Method Devised

The testing of complete valves was therefore abandoned in favor of a method involving fewer variables. A fixture was designed to hold metal specimens 1½ in. in diameter and ¼ in. thick. Incidentally, it is obvious that the use of such specimens instead of complete, special globe valves represented a worthwhile economy in the preparation of the test samples. This fixture, illustrated in the sketch, is of two-piece construction. In the lower part, or body, the specimen rests upon a shoulder and the upper part, which is essentially a straight bore nozzle, is screwed into the body until the four little feet, or spacers (0.005 in. in height), on the face of the nozzle contact the face of the specimen. The purpose of these spacers is to maintain the outlet of the nozzle at a constant distance from the face of the specimen.



Fixture for holding specimens

With the specimen in place in the fixture and with the nozzle screwed down in contact with it, saturated steam at 350 lb per sq in. pressure was admitted at the upper end of the nozzle through which it flowed to the 1/16 in. diameter outlet throat. Emission of the steam from the nozzle outlet caused a high velocity steam jet to impinge upon the face of the specimen. The steam, after striking the surface of the specimen, had to escape through the 0.005 in. space between the adjoining specimen and nozzle faces and was finally relieved from the fixture through drilled holes in the side of the body. Escaping from the point of impingement through this restricted area, the steam tended to erode the specimen surface radially as it traveled outward.

Several miscellaneous specimens were subjected to such a test. These were removed for examination at regular intervals, and it was found that a total test period of 100 hr was sufficient to yield valuable information as to the relative erosion resistance of the various metals. The 100 hr test was therefore established as standard and all results given were derived from tests of this duration.

Four of the special fixtures were used in conducting tests on four specimens at a time and, in order to eliminate the effect of possible minor differences in the fixtures or nozzles, the specimens were changed from one fixture to the next after each 25 hr period.

Test Results Summarized

The effect of the steam jet impingement upon the specimens was evidenced by a small pit approximately ⅛ in. in diameter in the surface. Classification of the metals was accomplished jointly by microscopically measuring the average depths of these craters in the specimens and by examining photomicrographs of the craters. In Table 1 the metals thus tested are classified as to the crater depths only, the specimens having the slightest impression heading the list and so on down the list.

In Table 2 the classification is also according to the crater depth measurements, but the metals are separated into groups, which arrangement shows the relative erosion resistance of the different types of metals.

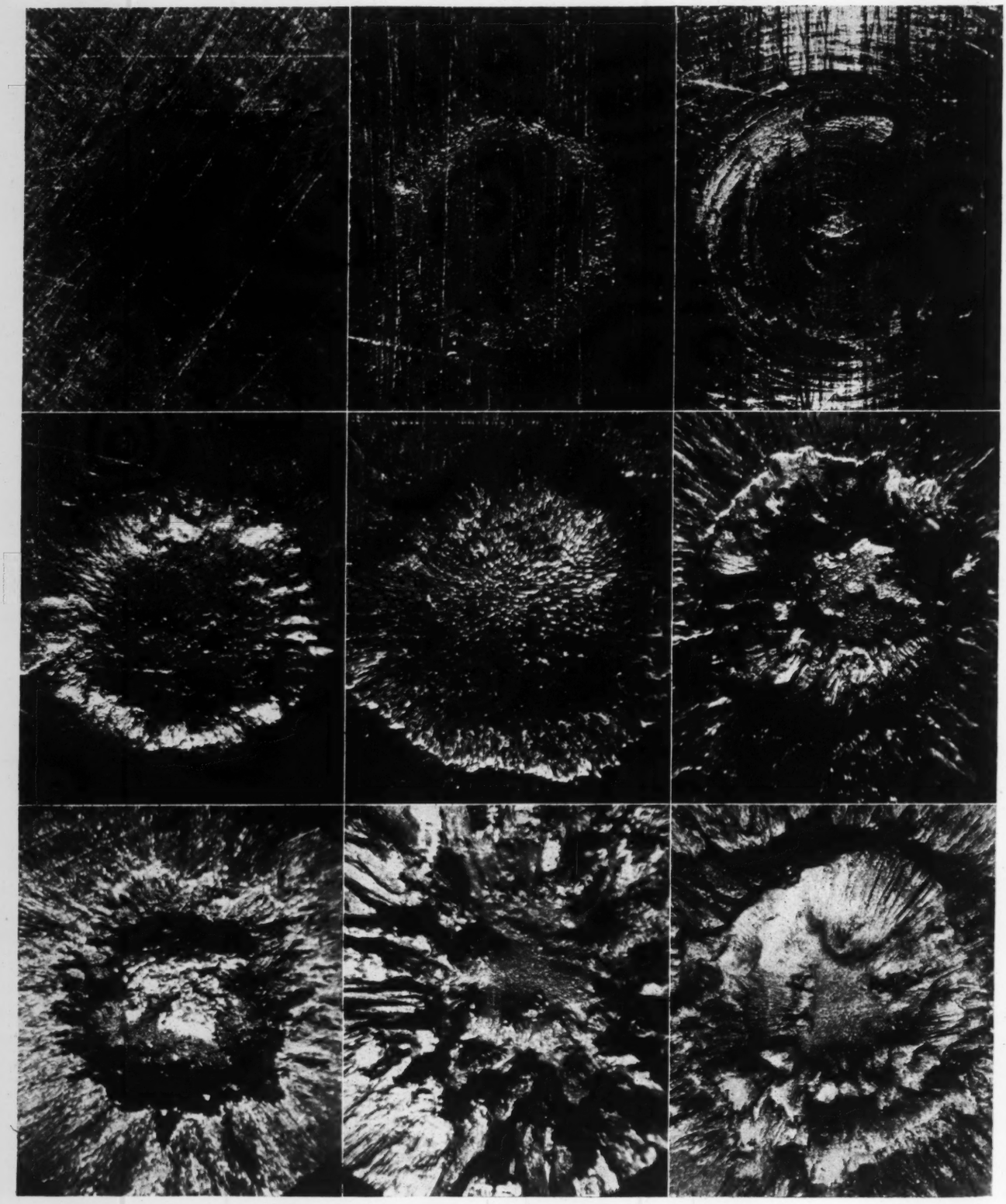
That *hardness is not the sole criterion of erosion resistance* is particularly well shown in the case of the series of nitrided steels tested. In Table 1 the nitrided steels are listed in order of their decreasing resistance to this type of erosion and no such corresponding order of the actual Brinell hardness readings taken on the specimens is found to exist. This is equally true for the other metals tested.

Somewhat better correlation of hardnesses and erosion resistance have been reported[1] on the basis of tests conducted by the research laboratories of Westinghouse Electric & Mfg. Co. Those tests, however, comprised the attachment of specimens to the rim of a rapidly rotating disc in such manner that once in every revolution of the disc each of the specimens passed through a high velocity jet of water. Such test conditions undoubtedly

[1] *Power*, September, 1932.

Table 1—Specimens Classified by Crater Depths

Identification Number	Specimens Tested	Depth of Impression, in.	Brinell Hardness
1	12 to 14% Chrome Stainless Iron—Bar Stock	0.00019	302
2	12 to 14% Chrome Stainless Iron—Forged & Heat Treated	0.00019	285
3	18-8 Chrome Nickel Alloy—Cast	0.00038	169
4	4 to 6% Chrome Molybdenum Alloy Cast Steel	0.00057	229
5	Cobalt Chromium Tungsten Alloy—Deposited	0.00076	317
6	18-8 Chrome Nickel Alloy Steel—Bar Stock	0.00095	187
7	18-8 Chrome Nickel Alloy Steel—Bar Stock	0.00095	197
8	12 to 14% Chrome Stainless Iron—Forged & Heat Treated	0.00114	444
9	Nickel Base Copper Tin Alloy—Cast	0.00190	221
10	Nickel Chrome Alloy Cast Steel	0.00285	232
11	Special Red Brass	0.00418	41
12	Monel Metal—Bar Stock	0.00532	207
13	85-5-5-5 Red Brass—Cast	0.00551	45
14	88-10-2 Bronze—Cast	0.00551	57
15	Monel Metal—Cast	0.00646	85
16	Copper Base Nickel—Tin Alloy	0.00665	99
17	88-12 Bronze	0.00684	74
18	High Strength Yellow Forging Brass	0.00735	138
19	Regular Yellow Forged Brass	0.01045	83
20	Electric Carbon Cast Steel	0.01387	163
21	Hard Cast Iron	0.01425	207
22	Gray Cast Iron	0.01710	194
23	Cupola Malleable Iron	0.01786	137
24	Forged Carbon Steel—S.A.E. 1035	0.01805	145
25	Cemented Tungsten Carbide	0.01920	800
	Nitrided Steels		
A	2½% Nickel—Bar Stock	0.00304	840
B	Chrome Vanadium—Bar Stock	0.00304	950
C	High Carbon & Chrome Iron	0.00342	1198
D	Forged Chrome Vanadium	0.00361	758
E	Forged Chrome Aluminum	0.00399	750
F	Forged Chrome Aluminum	0.00418	1155
G	Forged Chrome Vanadium	0.00437	739
H	Forged Chrome Aluminum	0.00760	1074
J	Chrome Aluminum—Bar Stock	0.00779	815



Top row, left to right—Specimens 1-4-6. *Middle row, left to right*—Specimens 11-16-20. *Bottom row, left to right*—Specimens 21-23-25

yield results of great value in the selection of materials for turbine blades, but the kind of erosion experienced in valve parts is not duplicated. The impact of the specimen with the water jet is a factor not ordinarily found in piping installations and it is the effect of this impact in these other experiments that probably accounts for the better showing of the harder metals.

The stainless irons and steels, while not particularly hard with respect to the nitrided steels, for example, were practically impervious to the attack of steam jet

erosion. This would seem to indicate that the cavities in the specimens were produced, in part at least, by the blowing away of the products of corrosion and that the excellent performance of the stainless steels was primarily attributable to the high degree of corrosion resistance.

Since erosion is probably the result of a combination of mechanical wearing away of the metal surface by the fluid and of the corrosion of the metal surface by the fluid, it is apparent that neither hardness nor corrosion resistance alone is sufficient. Considered in this light, the arrangement of the metals, as shown in Table 2, appears logical and consistent. The metals in the upper portion of the table possess both high corrosion resistance and sufficient hardness or resistance to purely mechanical erosion. Those metals farther down the scale are lacking partially in one or both types of resistance and some few metals at the bottom of the table have nothing to commend their use as valve seating materials.

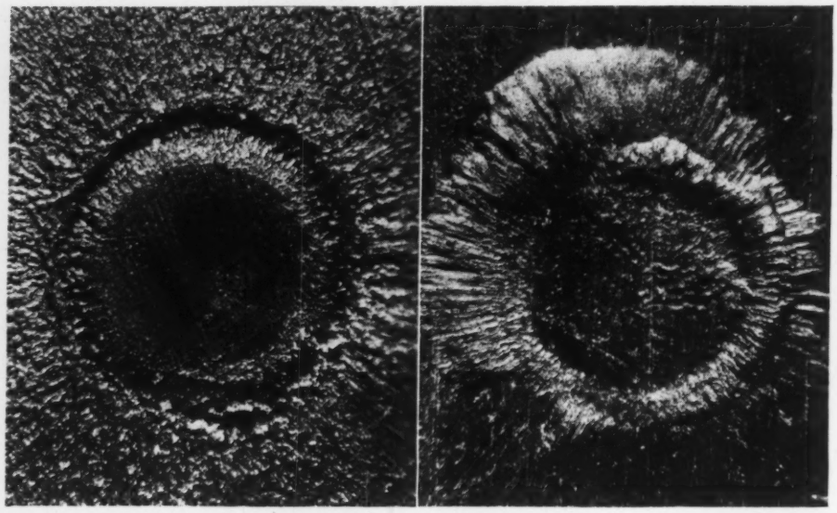
The photomicrographs shown convey a better picture of the varying effects of such steam jet erosion upon different metals than would any wordy description of the appearances of the specimens.

Table 2—Group Classification of Specimens Tested

Depth of Impression, Inches	Brass	Iron	Steel	Stainless Iron and Steel	Other Corrosion Resistant Metals	Nitrided Steels	Special Metals
0.0001 to 0.001			(4) 4-6% Chrome Molybdenum Alloy Cast Steel	(1) 12-14% Chrome Stainless Iron Bar Stock			(5) Cobalt Chromium Tungsten Alloy—Deposited
				(2) 12-14% Chrome Stainless Iron Forged & H. T.			
				(3) 18-8 Chrome Nickel Alloy—Cast			
				(6) 18-8 Chrome Nickel Alloy Steel—Bar Stock			
				(7) 18-8 Chrome Nickel Alloy Steel—Bar Stock			
0.001 to 0.002				(8) 12-14% Chrome Stainless Iron Forged & H. T.	(9) Nickel Base Copper Tin Alloy—Cast		
0.002 to 0.003			(10) Nickel Chrome Alloy Cast Steel				
0.003 to 0.004						(A) 2½% Nickel—Bar Stock	
						(B) Chrome Vanadium—Bar Stock	
						(C) High Carbon* & Chrome Iron	
						(D) Forged Chrome Vanadium	
						(E) Forged Chrome Aluminum	
0.004 to 0.005	(11) Special Red Brass					(F) Forged Chrome Aluminum	
						(G) Forged Chrome Vanadium	
0.005 to 0.006	(13) 85-5-5-5 Red Brass—Cast				(12) Monel Metal Bar Stock		
	(14) 88-10-2 Bronze—Cast						
0.006 to 0.007	(17) 88-12 Bronze				(15) Monel Metal—Cast		
					(16) Copper Base Nickel—Tin Alloy		
0.007 to 0.008	(18) High Strength Yellow Forging Brass					(H) Forged Chrome Aluminum	
						(J) Chrome Aluminum—Bar Stock	
0.010 to 0.014	(19) Regular Yellow Forged Brass		(20) Electric Carbon Cast Steel				
0.014 to 0.020		(21) Hard Cast Iron	(24) Forged Carbon Steel S.A.E. No. 1035				(25) Cemented Tungsten Carbide
		(22) Gray Cast Iron					
		(23) Cupola Malleable Iron					

Selection of Seating Materials

It would seem then that the selection of valve seating materials on the basis of these erosion data would be a very simple matter. This is not the case, however, since erosion resistance of a metal is, while one of the most important, still but one of the requisites. A consideration of the mechanical wear characteristics or the tendency toward seizing and galling of the various metals, as applied to valve seating parts, would cause an entirely different selection of materials than any selection based on erosion resistance alone.



Left to right—Specimens A-J

It is unfortunate that the 12 per cent chrome stainless iron, whether in bar stock or forged and heat treated form, the 18-8 stainless steel in cast or bar stock form, and the chrome molybdenum cast steel, are eliminated from the realm of gate valve seating metals, except for oil service, unless used in combination with some harder material, because of a tendency to tear up when operated without lubrication under high loads. The converse of this holds for nitrided steels, for here we have a class of extremely hard metals that can be operated without lubrication indefinitely under high loadings with no tendency toward tearing or galling, but these nitrided steels are subject to corrosion and exhibited a low degree of steam jet erosion resistance. This experience with nitrided steels has been further substantiated by the failure of nitrided valve discs due to wire drawing in actual valve service.

The ultimate result is that neither the most erosion resistant metal nor the metal most resistant to galling under load can be generally accepted for valve seat service. A compromise must usually be effected, tempering the choice with the knowledge as to whether erosion resistance, corrosion resistance, or resistance to galling is of paramount importance.

Inasmuch as an investigation of this type is never completed and as tests along these lines are still in progress, this is presented more in the nature of a progress report rather than as a definite set of conclusions on this relatively unexplored subject. The writer wishes to acknowledge, in general, the valuable assistance of the personnel of the industrial laboratory, division of research and development, Crane Co., and special acknowledgment is made to Mr. W. P. Kliment of the same laboratory for the design of the special fixture and for his work in conducting the actual steam tests.

Air Conditioning Review—

(*Concluded from page* 31)

connected horsepower was 25,942 hp; therefore, 1½ hp may be considered equivalent to one ton, except where there are many well water or other jobs where electric driven refrigerating machines are not used. One hp of connected load would therefore provide air conditioned space for 3.5 persons, using this method).

In using the data presented in Table 2, it should be borne in mind that they do not cover all installations. Source of the figures is the public utility supplying electrical energy and where current is generated privately—as it is in many industrial plants—there is no way of finding out from any central organization the air conditioning load. Also, it should be realized that figures on connected horsepower for air conditioning do not in all cases give a true picture of air conditioning capacity, for in many areas well water is used as the cooling means, and steam jet, silica gel, and ice jobs do not have electric motor driven refrigerating machines. The footnotes of Table 2 endeavor to present such data as are available on this.

Reliable statistics on air conditioning are still difficult to obtain, and many figures which are not fact or are entirely too incomplete have been published and quoted widely. It is to be hoped that it will be possible to secure more detailed and dependable data in the not too distant future. The *Edison Electric Institute* is understood to be working on the matter of a standardized reporting form for air conditioning installations.

The courtesies of the utility companies serving the respective areas in making the information presented in Tables 1 and 2 available are gratefully acknowledged.

Table 3—Number of Air Conditioned Railroad Passenger Cars in Operation

(*Data from Association of American Railroads as of Oct.* 1, 1936)

System	1933	1934	1935	1936 (10 mos.)	Total to Date
Ice activated	297	749	993	951	2990
Mechanical	310	932	1808	911	3961
Steam	41	197	549	204	991
Power drive*	...	...	10	59	69
Front end drive	...	8	6	6	20
Total	648	1886	3366	2131	8031
Railroad owned					3907 cars
Pullman owned					4124 cars

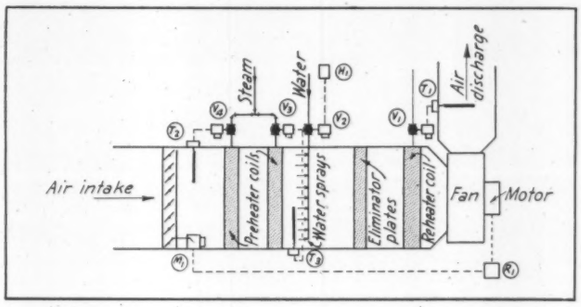
*Waukesha "ice engine."

CONTROLS

By C. L. Ringquist*
Reference Sheet 5

Heating, Ventilating and Humidifying Systems

In many ventilating systems a certain amount of heating, as well as humidifying, is done. This is one system of this type, in which all outside air is used.



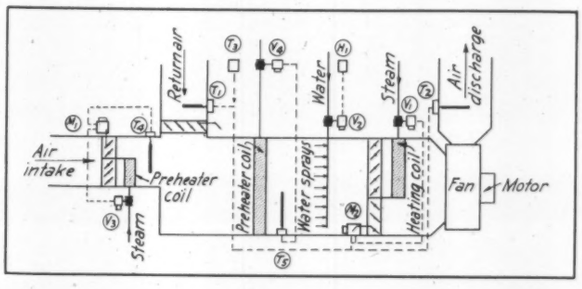
Symbols

H_1	Room humidistat
M_1	Damper motor
R_1	Relay
T_1	Room or duct thermostat
T_2	Duct thermostat
T_3	Duct thermostat
V_1	Modulating valve
V_2	Two position valve
V_3	Modulating valve
V_4	Two position valve

Cycle—Outside air damper is automatically closed at all times fan is not in operation. T_2, set at 35 deg, controls V_4 so that it is open only when the incoming air is below 35 deg. T_3 modulates V_3 to maintain constant entering air temperature to sprays. H_1 controls action of sprays through V_2.

Duct thermostat T_1, or a room thermostat, controls amount of steam supplied to reheating coil by modulating V_1.

Similar system, but incorporating more accurate control on the reheating coil, as well as allowing some recirculated air and including a preheater in outside air intake.



Symbols

H_1	Humidistat
M_1	Damper motor
M_2	Damper motor
T_1	Duct thermostat
T_2	Duct thermostat
T_3	Room thermostat
T_4	Duct thermostat
T_5	Duct thermostat
V_1	Modulating valve
V_2	Two position valve
V_3	Two position valve
V_4	Modulating valve

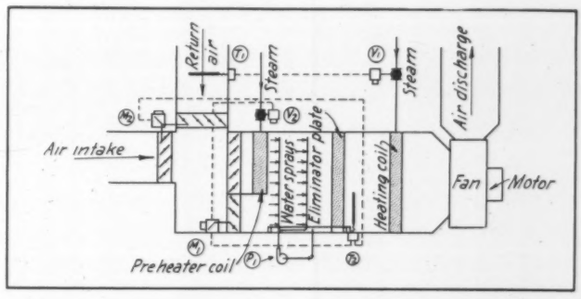
Cycle—T_4 acts to maintain constant air temperature leaving outside air duct into plenum by regulating amount of air passing through or around preheater coil. This is accomplished by operating face and bypass dampers controlled by M_1, which is equipped with an auxiliary contact connected to V_3 so that when all the air is being bypassed steam is shut off to outside air preheating coil.

T_5 maintains constant temperature of air to sprays by regulating amount of steam supplied to main preheater coil through V_4.

H_1 controls amount of humidification by opening or closing V_2.

Room temperature is maintained by T_1, or if preferred a room thermostat T_3, which controls amount of air bypassing reheating coil through M_2. M_2 is also controlled by T_2, which acts as a low limit control to prevent discharge of cold air into room. M_2 is equipped with an auxiliary contact connected to V_1. This valve acts to shut off steam supply to reheating coil when all the air is passing through bypass damper.

A different type of control system, in which operation consists of drawing a portion of outside air and recirculated air, mixing these two quantities in a plenum chamber, drawing this mixture either through or around a preheating coil, humidifying this partially heated air, reheating this air by means of the reheating coil and discharging this air into the system of duct work.



Symbols

M_1	Damper motor
M_2	Damper motor
P_1	Recirculating pump
T_1	Duct or room thermostat
T_2	Temperature-controller
V_1	Modulating valve
V_2	Modulating valve

Cycle—T_2 operates to maintain constant air temperature and thereby constant dewpoint leaving the sprays. T_2 has two circuits, the first circuit operating to modulate M_2 thus changing the quantities of outside and recirculated air. If discharge air temperature from washer continues to fall after outside air quantity has been reduced to a fixed minimum, T_2 starts to modulate M_1 to reduce quantity of air passing through bypass damper and increases quantity passing through preheating coil. The reverse action takes place upon increasing temperature leaving washer.

M_1 is equipped with an auxiliary contact to close V_2 when all of the air is bypassing the coil.

P_1 recirculates the washer spray water at all times.

Room temperature is controlled by T_1 which acts to modulate amount of steam supplied to reheating coil through V_1.

A room thermostat may be substituted for the duct thermostat if desired.

An additional duct thermostat may be installed in the fan discharge to act as a low limit control on V_1 when there is a possibility of low temperature air being delivered to the duct work and into the conditioned space.

*Air Conditioning Department, The Trane Co., La Crosse, Wis.

Although data on automatic controls for heating, humidifying, dehumidifying, ventilating, cooling and complete air conditioning may be had from numerous sources, information on groups of controls applicable to various types of systems is not so readily available. The author has therefore diagrammed typical control layouts, with each of which is given an explanation of the control cycle. . . For the purpose of illustration, central fan coil types of systems are used; the control arrangements described are equally applicable to units built up to perform the same functions. . . Types of systems covered by this series include humidifying; ventilating; heating and ventilating; heating, ventilating and humidifying; cooling, dehumidifying and ventilating; cooling, dehumidifying, ventilating and humidifying; heating, ventilating, dehumidifying and cooling; heating, ventilating, dehumidifying, cooling and humidifying; and zone control systems.

RESEARCH

In laboratories throughout the land, the search for fundamental data—on which progress in heating, piping and air conditioning engineering must be based—goes forward. . . . Outstanding in this work is the *American Society of Heating and Ventilating Engineers*, whose research program is carried on at the society's own laboratory and at many cooperating institutions under the direction of the *A. S. H. V. E.* committee on research. . . . Many manufacturers and private investigators are also engaged in studies of heating, piping and air conditioning problems . . . The following pages review briefly the *A. S. H. V. E.'s* research plans for 1937, describe the recently completed practical air conditioning laboratory one manufacturer is using for research

Treatment of Disease by Air Conditioning to be Studied by A.S.H.V.E. in 1937 Research

By Brewster S. Beach*

■ **The comprehensive scope of the *American Society of Heating and Ventilating Engineers'* research work should be of especial interest to readers of HEATING, PIPING, AND AIR CONDITIONING as they face the interesting new problems that 1937 will offer. This general review and forecast of the society's work and its plans for 1937 is intended to be helpful in keeping abreast of trends**

A WHOLE new field for air conditioning may result from the investigations of its utility in treating disease to be carried on by the *A.S.H.V.E.* committee on research as part of its 1937 program. One phase of this study will be development of the use of air conditioning to produce the high fevers whose sensational results in the treatment of numerous diseases have been the subject of many articles in the popular magazines.

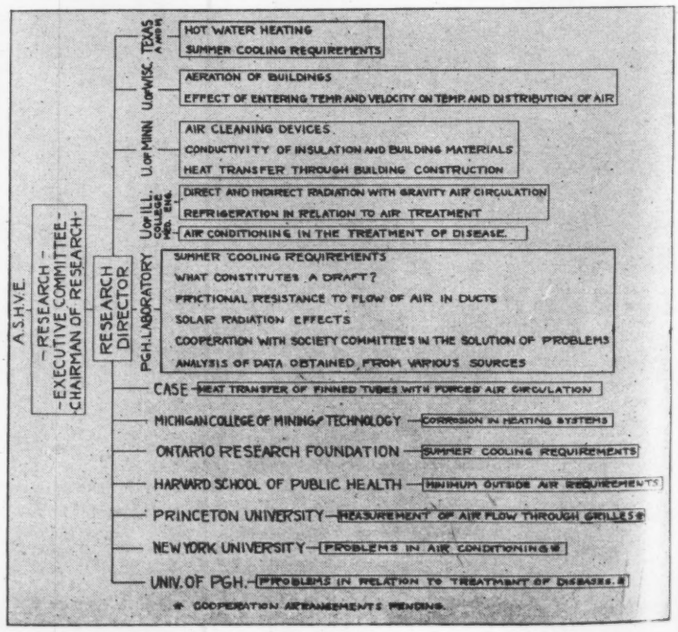
So important have become the possibilities of air conditioning in the treatment of disease, exploitation of which many believe will be the next great stride in the industry's growth, that the society has appointed a committee to head this work, of which the fever therapy investigation is a part. Serving on this committee are Dr. E. V. Hill, chairman; N. D. Adams, J. J. Aeberly, John Howatt, Prof. A. P. Kratz, Prof. V. L. Sherman, and E. L. Stammer.

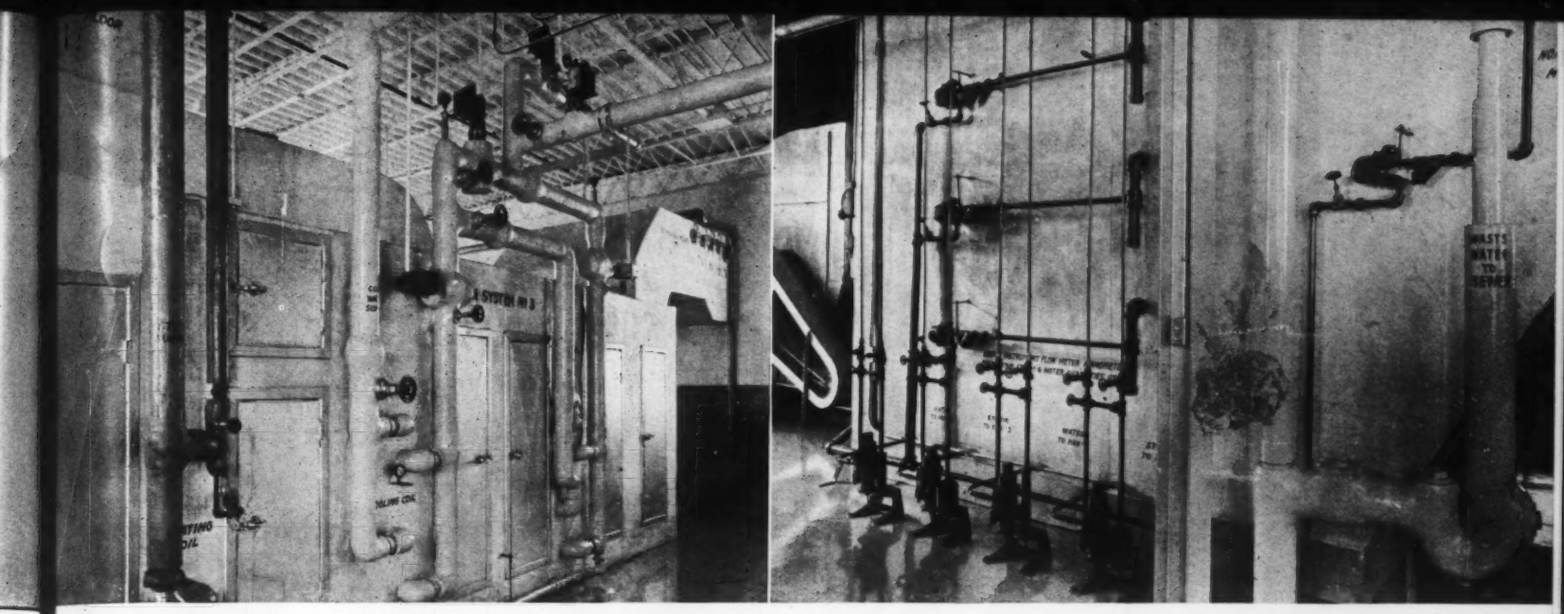
Data secured by pioneering investigation of the society upon the physiological reactions of normal humans, which, the committee on research points out, led to the suggestion of physicians that the society cooperate with them in the new inquiry, will be placed at the disposal of the medical fraternity at large in order that new knowledge beneficial both to the industry and to medicine may be uncovered. The first work in this direction will be discussed at the *A.S.H.V.E.'s* annual meeting this month in a joint paper by Dr. M. B. Ferderber, F. C. Houghten, director of research, and Carl Gutberlet. Working under the direction of physicians at Saint Francis Hospital in Pittsburgh, the society's research laboratory designed an air conditioned "fever box" that has been remarkably effective in treating social diseases.

Further research in similar fields will be carried on in collaboration with the University of Pittsburgh medical school during the coming year, and the work will be extended in a research agreement under which medical scientists of the West Side Hospital, part of the medical school of the University of Illinois at Chicago, will take part. Here, careful study of the effects of various tem-

*Director, Information Service, *A.S.H.V.E.* Committee on Research. Member of Board of Consulting and Contributing Editors.

Investigations being conducted by *A. S. H. V. E.* committee on research in cooperation with universities and other laboratories


A.S.H.V.E.
-RESEARCH-
-EXECUTIVE COMMITTEE-
-CHAIRMAN OF RESEARCH-
RESEARCH DIRECTOR
PGH. LABORATORY
SUMMER COOLING REQUIREMENTS
WHAT CONSTITUTES A DRAFT?
FRICTIONAL RESISTANCE TO FLOW OF AIR IN DUCTS
SOLAR RADIATION EFFECTS
COOPERATION WITH SOCIETY COMMITTEES IN THE SOLUTION OF PROBLEMS
ANALYSIS OF DATA OBTAINED FROM VARIOUS SOURCES
U. OF ILL. COLLEGE MED. ENG.
DIRECT AND INDIRECT RADIATION WITH GRAVITY AIR CIRCULATION
REFRIGERATION IN RELATION TO AIR TREATMENT
AIR CONDITIONING IN THE TREATMENT OF DISEASE.
U. OF MINN.
AIR CLEANING DEVICES
CONDUCTIVITY OF INSULATION AND BUILDING MATERIALS
HEAT TRANSFER THROUGH BUILDING CONSTRUCTION
U. OF WISC.
AERATION OF BUILDINGS
EFFECT OF ENTERING TEMP. AND VELOCITY ON TEMP. AND DISTRIBUTION OF AIR
TEXAS A. AND M.
HOT WATER HEATING
SUMMER COOLING REQUIREMENTS
CASE — HEAT TRANSFER OF FINNED TUBES WITH FORCED AIR CIRCULATION
MICHIGAN COLLEGE OF MINING & TECHNOLOGY — CORROSION IN HEATING SYSTEMS
ONTARIO RESEARCH FOUNDATION — SUMMER COOLING REQUIREMENTS
HARVARD SCHOOL OF PUBLIC HEALTH — MINIMUM OUTSIDE AIR REQUIREMENTS
PRINCETON UNIVERSITY — MEASUREMENT OF AIR FLOW THROUGH GRILLES *
NEW YORK UNIVERSITY — PROBLEMS IN AIR CONDITIONING *
UNIV. OF PGH. — PROBLEMS IN RELATION TO TREATMENT OF DISEASES *
* COOPERATION AGREEMENTS PENDING.



Left—Fan System No. 3. Note the controllers in the outdoor air intake, the many access doors and the six control valves. . . . . *Right*—Fan System No. 2. Note the four flow meter manometers for measuring the flow of water and steam to Fan Systems No. 2 & 3

peratures and humidities on the vital organs of the body is expected to result in setting up standards for air conditioning in hospitals. Also contemplated by the Chicago investigators is an inquiry into the use of specially conditioned air to treat some forms of rheumatism and heart disease.

The society's program for continued research (for which it is engaged in raising a large research fund for increased activity over the next two years) embraces further investigations on many subjects. Capture for interior air of the imponderable quality which is responsible for the invigorating effect of "fresh air" is one of these. This property is thought, on the basis of experiments done at Harvard University in cooperation with the *A.S.H.V.E.*, to be due to negative electrification by the sun's or cosmic rays. Artificial imitation of this is one of the projects by which the society hopes to make conditioned air more closely adapted to human needs.

Among other plans are:

Studies of insulating materials to determine best practices, as well as cures for recognized faults in those in current use. Included will be development of new methods of increasing insulation of concrete, studies on proper installation of glass and determination of the correct employment of the newly-developed glass brick, and commercial adaptation of the recently discovered fact that flat roofs may be insulated and preserved by flooding with pools of water.

Study of heat generating equipment and development of improvements in these and in heat conducting and heat radiating equipment.

Development of optimum design for air circulating ducts and small fittings, as well as for filtering apparatus.

The broad basis of *A.S.H.V.E.* research is indicated by the fact that there are some 30 subjects under investigation, either on a continuing basis from previous years or in the nature of new projects.

Practical Air Conditioning Laboratory Designed to Yield Information on Control and Other Subjects

By J. E. Haines*

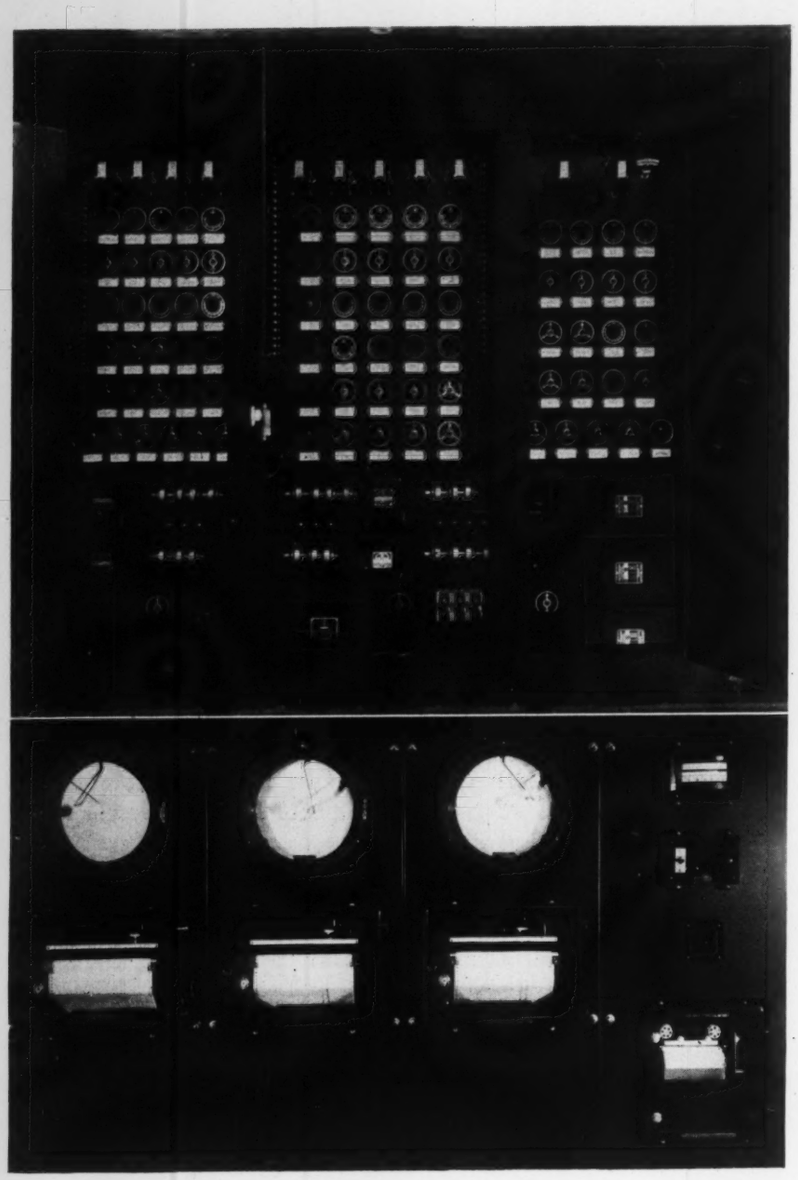
■ **Believed to be one of the most complete experimental systems in the world, the practical air conditioning laboratory described here has been arranged to permit research on standardizing automatic control methods, comfort zone determinations, air distribution, air filtration, and other subjects. Many possible variations in mechanical equipment are allowed for in the system's design**

LAST spring the Minneapolis-Honeywell Regulator Co. decided to obtain first hand experience and information on air conditioning and the application of automatic controls to air conditioning. A conditioning system was therefore designed and installed in their Minneapolis executive offices which is believed to be one of the most complete experimental systems in the world.

The system includes three central fan conditioners, two of which use coils for cooling and precooling and the third a two stage air washer for cooling and precooling. Each conditioner is equipped with preheaters and reheaters, and the two conditioners using coils for cooling are equipped with water sprays for humidification. All of the possible variations in the types of mechanical equipment such as fans, filters, and coils were included in the conditioner design.

Each conditioner is equipped with temperature and humidity controllers, and with motor operated face dampers, bypass dampers, mixing dampers, volume dampers, coil valves, and three way mixing valves in so

*Assistant Manager, Modutrol Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.



Top—Central control panel which permits changing from one type of automatic control system to another almost instantly. . . . . *Bottom*—Instrument board which provides a constant chart record of eleven dry bulb temperatures, the flow of three water lines and three steam lines, the carbon dioxide content of the flue gas from the boiler, and an indication of 24 temperatures in the conditioners and in the air conditioned space

complete a fashion that any known method of automatic control may be used at any time, including all forms of compensated automatic control.

A central control board permits changing from one type of automatic control system to another almost instantly on any conditioner, thereby permitting a very complete comparison of each individual type of control system. An instrument board provides a constant chart record of 11 dry bulb temperatures, seven wet bulb temperatures, the flow of three water lines and three steam lines, and the carbon dioxide content of the flue gas from the boiler. In addition, the dry bulb temperatures at 24 points throughout the conditioners and conditioned spaces may be read at any time on a deflection type resistance thermometer, thus providing for a complete record of all experimental results.

At the present time, well water is used exclusively for cooling and dehumidification but provision was made for adding direct expansion coils in two of the conditioners at a later date. The two wells have a total capacity of 1400 gpm at approximately 50 F.

Conditioning Systems 1, 2 and 3 have capacities of 20,000, 22,700 and 13,900 cfm respectively, or a total of 56,600 cfm. The total heat removal capacity is equivalent to 248 tons of refrigeration. The water which has passed through the cooling coils may be sprayed on the roof or sent directly to the sewer as desired.

It is planned to conduct the following types of experimental work, some of which has been under way for several months:

Standardization of Control Methods

In the past and at present a conditioning system is usually designed completely in every detail before the application of automatic controls is considered. The automatic control engineer is then expected to recommend a control system which will provide almost perfect results at a minimum of expense and in many cases this is impossible. It has been necessary on many installations to consider the automatic controls as individual units and not as a complete control system with all portions of the system coordinated with the operation of the conditioning system. It has often been necessary to resort to tricky and complicated groups of controls in order to

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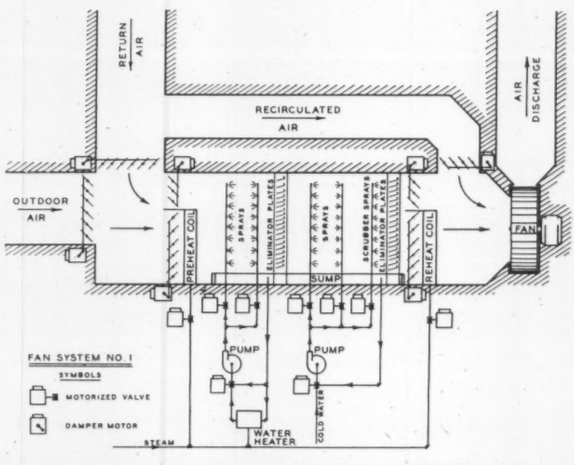

Schematic diagram of Conditioning System No. 1. Note the multiplicity of automatic dampers, damper motors, motor valves, etc., permitting changes in control methods for experimental work

Strength and Design of Covers and Flanges for Pressure Vessels and Piping

[Part 3]

By T. McLean Jasper*, H. Gregersen*, and A. M. Zoellner*

THE construction of a vessel or pipe line for high pressure service involves a balance in the design at every point so that the safety of such equipment can be assured.

Previous investigations have established the necessity for and the required amount of reinforcement for openings in vessel walls and for the proper shapes of heads of vessels. The present investigation aims to go into the question of covers and flanges of openings. Part 1, published in November, was concerned with covers and ring flanges, and Part 2, in December, with hubbed flanges, which subject is continued this month.

Comparison between the Results Obtained from Formulas and Test Flanges

In the following figures the theoretical formulas have been plotted for comparison and test results are shown on the plot in order to establish the relative value and accuracy of the formulas.

With regard to the test material and the test procedure these are the same as for the ring flanges previously described. The sizes and variations made for the ring part of the hubbed flanges tested are the same as for the ring flanges previously tested. In this manner a direct comparison of the strength of ring and hubbed flanges is possible. In addition to the variations of the ring part of the flange, variations have been made of the hub thickness and the fillet radius in order to establish the correctness of Equation 23 developed for the fillet coefficients and the value of the factor n.

With regard to the length of the hub, theoretical investigations to be dealt with in Appendix 3 have brought out that for hub lengths:

$$H \geqq \sqrt{td} \qquad [26]$$

The maximum bending stress in the junction between ring and hub remains practically constant. In all tests made with hubbed flanges the length of the hub was taken considerably larger than the minimum value calculated from Equation 26.

Variation of External Moment with Flange Thickness and Fillet Radius

In the design of hubbed flanges engineers are mostly concerned about the variation in strength with the flange thickness for given inside and outside diameters. Figs. 9 and 10 show the variation of external moment with flange thickness according to the above theoretical formulas for smaller and larger hubbed flanges respectively. They also show the test results obtained with flanges provided with circular fillets of various radii.

From Figs. 9 and 10 it can readily be seen that the strength increases with increased fillet radius. A comparison between the test curves and the theoretical curves shows that the shape and slope of the test curves are in conformity with the shape and the slope of the theoretical curve calculated from Timoshenko's formula.

Figs. 11 and 12 show the test curves, without the test points, given in Figs. 9 and 10, respectively, as compared with the theoretical curves calculated from Formula 25, which is a combination of Timoshenko's Formula 22 and the Formula 23 developed for the fillet coefficients.

Since the test points for small flanges without fillet are distributed around the theoretical curve calculated from Timoshenko's formula, this curve, as shown in Figs. 9 and 11, has been considered identical with the test curve for flanges without fillet. The test curves in Fig. 11 show that as the fillet radius is increased from 0 to ¼ in. the strength increases rapidly. This rapid increase is believed to be due to the disappearance of the stress concentration. As the fillet radius is increased from ¼ to ½ in., the strength of the test flanges shows a smaller comparative increase. A further increase of the fillet radius from ½ to ¾ in. results in a comparatively rapid increase of the strength of the test flanges. It is believed that this increase is due to the removal of the dangerous section to a certain location along the hub where the magnitude of the bending moment causing fracture has a comparatively small value. All test flanges with large fillets broke in the part of the fillet close to the hub.

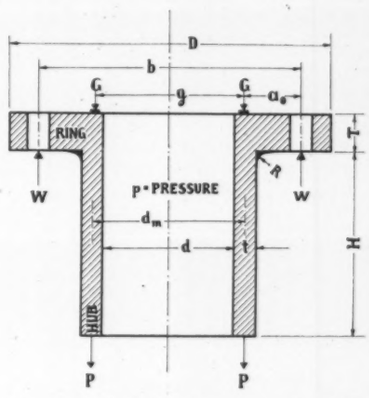

Fig. A—Longitudinal section of hubbed flange with the forces acting on it

The theoretical curves in Fig. 11 indicated as heavy lines show a more uniform increase of the strength with increased fillet radius than do the test curves. As can be seen from a comparison between the test curves and theoretical curves in Fig. 11 the theoretical curves are generally on the safe side and are therefore reliable for application to the design of small flanges.

With regard to the theoretical curve calculated from Timoshenko's formula, the shape and slope is in good conformity with the test curves shown in Fig. 11. However, its coincidence with the test curve for zero fillet radius indicates that it shows rather too low strength, since the stress concentration is not provided for in the formula.

The shape and slope of the test curves for large flanges shown in Fig. 12 can be seen to be in good conformity with the shape and slope of the theoretical curves calculated from Formula 25.

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Illustrations reproduced by courtesy of the A. O. Smith Corp.

This paper was presented at the annual meeting of the *American Society of Mechanical Engineers*, December, 1934, New York, N. Y., but has not heretofore been available in published form.

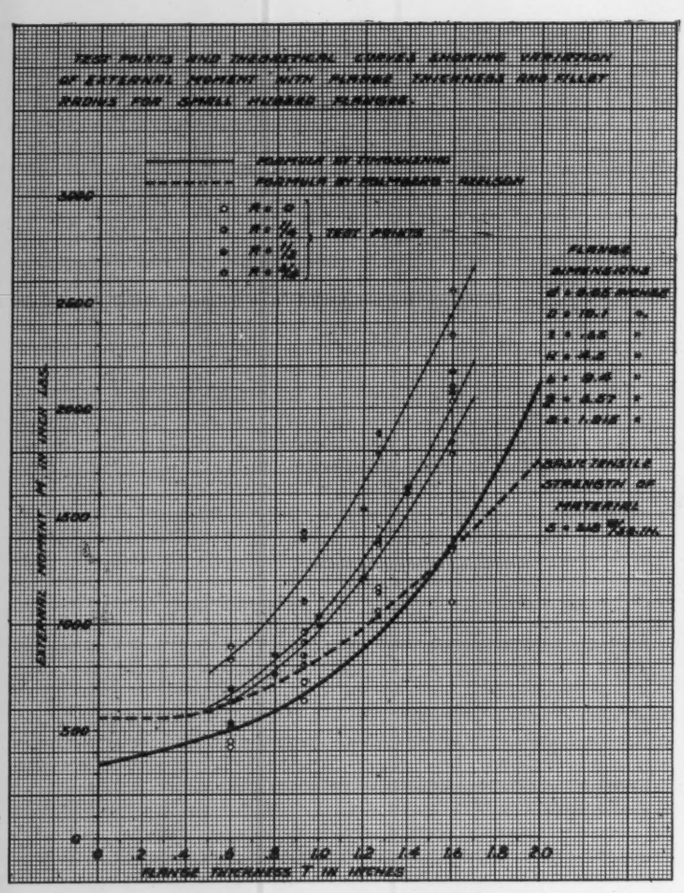


Fig. 9—Test points and theoretical curves showing variation of external moment with flange thickness and fillet radius for small hubbed flanges

Flange dimensions (in inches)—*d*, 5.05; *D*, 10.1; *t*, 0.65; *H*, 4.5; *b*, 9.4; *g*, 5.57; *a*, 1.915. Basic tensile strength of material, *S*, 318 lb per sq in.

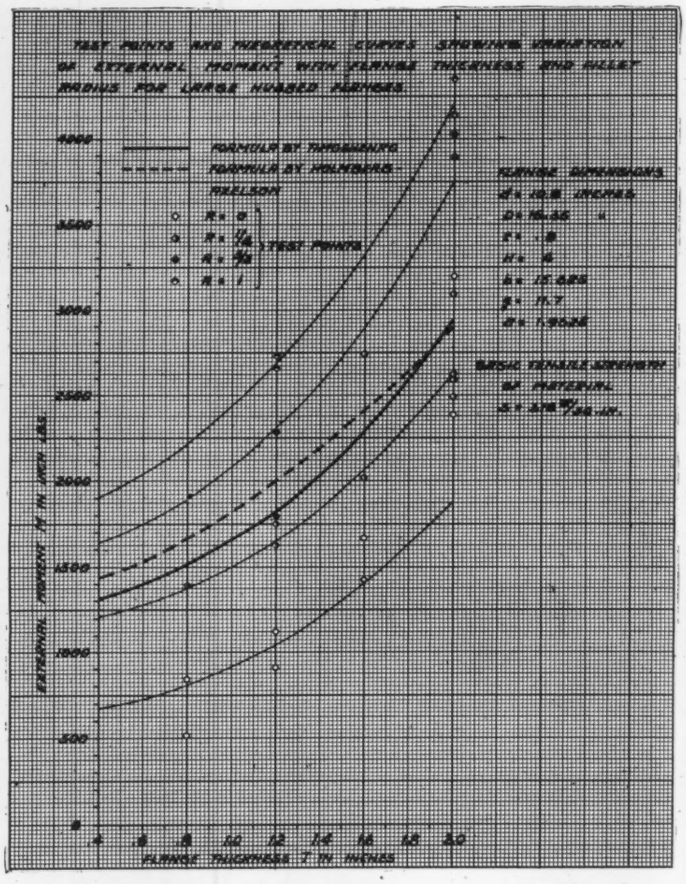


Fig. 10—Test points and theoretical curves showing variation of external moment with flange thickness and fillet radius for large hubbed flanges

Flange dimensions (in inches)—*d*, 10.9; *D*, 16.35; *t*, 0.8; *H*, 4; *b*, 15.625; *g*, 11.7; *a*, 1.9625. Basic tensile strength of material, *S*, 318 lb per sq in.

However, in the range of small fillets the test curves show considerably lower strength than the theoretical curves. Evidently this is due to the detrimental effect of the stress concentration in the brittle test material. Also in the range of large fillets the test curves show slightly lower strength than do the theoretical curves. The general low strength of the large flanges is believed to be due to residual stresses set up in the flanges when cast. This belief is based on the fact that some of the rather large castings cracked, due to heat expansion, before they could be taken out of the mould.

Since the number of small test flanges is considerably larger than the number of large test flanges, and the results obtained with the small test flanges are more consistent than the results obtained with the large test flanges, the theoretical investigations made have been largely based on the results obtained with the small test flanges.

A close investigation of the relative position of the test curves reveals that the per cent difference in strength between the test curves is practically independent of the flange thickness. Thus we may draw the conclusion that the influence of the fillet radius on the strength is independent of the flange thickness, which checks with the theoretical fillet investigation, previously described, since the flange thickness T does not appear in the Equation 23 developed for the fillet coefficients.

A comparison between Figs. 4 and 5, and 9 and 10, respectively, shows that the strength of ring flanges generally is lower than the strength of hubbed flanges of the same dimensions. The magnitude of this difference in strength depends greatly on the dimensions, and no fixed ratio exists between the strength of hubbed flanges and ring flanges.

List of Symbols Used

W—Total bolt load

G—Gasket load

D—Outside diameter of cover, ring, or flange

T—Thickness of hub in a hubbed flange

S—Stress

S_r—Modulus of rupture

$M=Wa$—External moment applied or assumed in design

M_o—moment per unit length of circumference

Q—Force

Q_o—Shearing force per unit length of circumference

M_{test}—Moment applied in test samples at failure

S_{test}—Stress obtained in test samples at failure

b—Bolt circle diameter

g—Gasket diameter

d—Inside diameter of flange or ring opening

a—Distance between gasket and bolt circle

a_o—Distance from bolt circle to center of hub thickness in a hubbed flange

d_m—Mean diameter of hub in a hubbed flange

t—Thickness of hub in a hubbed flange

μ—Poisson's ratio

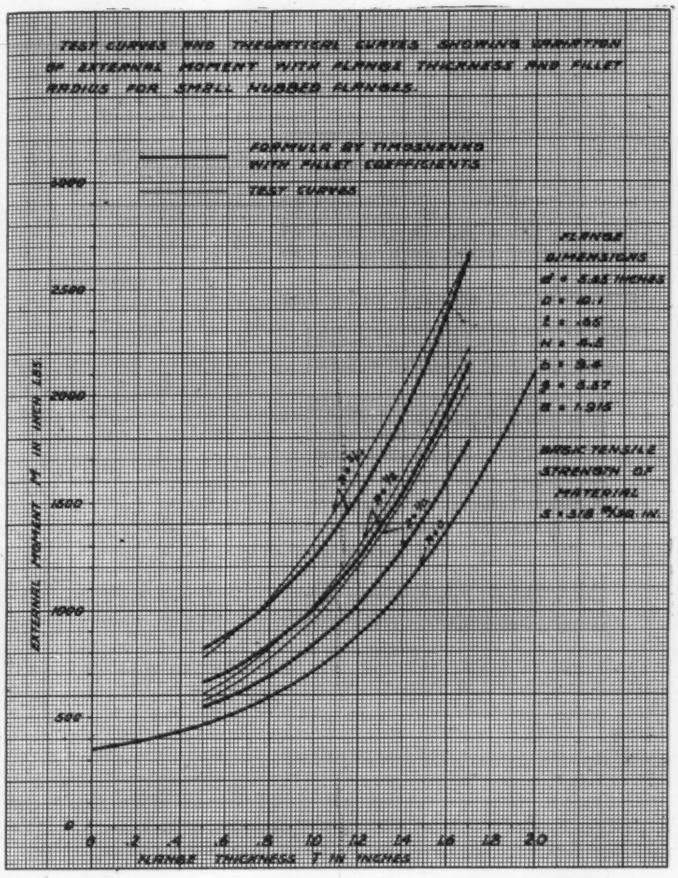

TEST CURVES AND THEORETICAL CURVES SHOWING VARIATION OF EXTERNAL MOMENT WITH FLANGE THICKNESS AND FILLET RADIUS FOR SMALL HUBBED FLANGES
FORMULA BY TIMOSHENKO WITH FILLET COEFFICIENTS
TEST CURVES
FLANGE DIMENSIONS
BRAKE TENSILE STRENGTH OF MATERIAL
EXTERNAL MOMENT M IN INCH LBS.
FLANGE THICKNESS T IN INCHES

Fig. 11—Test curves and theoretical curves showing variation of external moment with flange thickness and fillet radius for small hubbed flanges

Flange dimensions (in inches)—*d*, 5.05; *D*, 10.1; *t*, 0.65; *H*, 4.5; *b*, 9.4; *g*, 5.57; *a*, 1.915. Basic tensile strength of material, *S*, 318 lb per sq in.

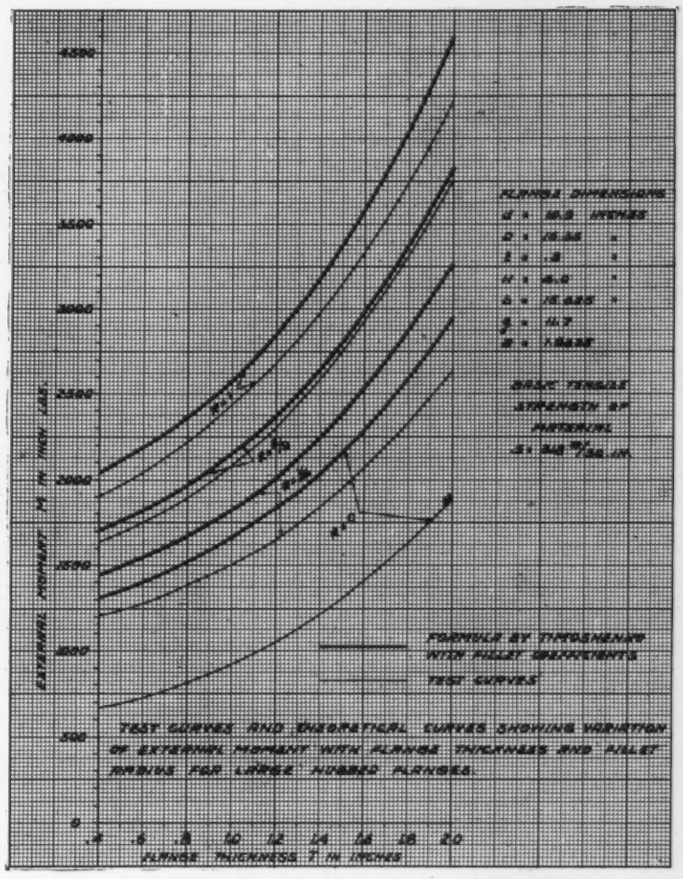

FLANGE DIMENSIONS
BRAKE TENSILE STRENGTH OF MATERIAL
FORMULA BY TIMOSHENKO WITH FILLET COEFFICIENTS
TEST CURVES
TEST CURVES AND THEORETICAL CURVES SHOWING VARIATION OF EXTERNAL MOMENT WITH FLANGE THICKNESS AND FILLET RADIUS FOR LARGE HUBBED FLANGES
EXTERNAL MOMENT M IN INCH LBS.
FLANGE THICKNESS T IN INCHES

Fig. 12—Test curves and theoretical curves showing variation of external moment with flange thickness and fillet radius for large hubbed flanges

Flange dimensions (in inches)—*d*, 10.9; *D*, 16.35; *t*, 0.8; *H*, 4.0; *b*, 15.625; *g*, 11.7; *a*, 1.9625. Basic tensile strength of material *S*, 318 lb per sq in.

Variation of External Moment with Hub Thickness and Fillet Radius

In the design of hubbed flanges engineers are concerned about the influence of the hub thickness on the strength of the flange. Fig. 13 shows the variation of the external moment with hub thickness according to the above theoretical formulas for smaller hubbed flanges. They also show the test results obtained with flanges provided with circular fillets of various radii.

From Fig. 13 it can readily be seen that the strength increases with increased fillet radius. A comparison between the test curves and the theoretical curves shows that the shape and slope of the test curves are in conformity with the shape and slope of the theoretical curve calculated from Timoshenko's formula.

Fig. 14 shows the test curves, without the test points, given in Fig. 13, as compared with the theoretiral curves calculated from Formula 25, which is a combination of Timoshenko's Formula 22 and the Formula 23 developed for the fillet coefficients.

Since the test points for flanges without fillet are distributed around the theoretical curve calculated from Timoshenko's formula, this curve as shown in Figs. 13 and 14 has been considered identical with the test curve for flanges without fillet. With regard to the variation in strength with the fillet radius, this is the same as shown in Fig. 11 previously described.

A close investigation of the relative position of the test curves reveals that the per cent difference in strength between the test curves decreases with decreased hub thickness. Thus we may draw the conclusion that the influence of the fillet radius on the strength is dependent on the hub thickness, which checks with the theoretical fillet investigation, previously described, since the hub thickness *t* is contained in the Equation 23 developed for the fillet coefficients.

A comparison between Fig. 14 and Fig. 11 shows that the strength of hubbed flanges increases faster with increased hub thickness than with increased flange thickness. Thus for large flanges on pressure vessels, often resulting in extremely large flange thicknesses, it may be more economical to increase the hub thickness (or reinforce the hub) to obtain the required strength rather than to increase the flange thickness.

Variation of External Moment With Flange Width

In the design of hubbed flanges engineers may be concerned about the variation in strength with the outside flange diameter (or flange width) for given inside flange diameter, hub and flange thickness. In other words: Does it pay to make the diameter of the bolt circle small, resulting in flanges of small flange width, or *vice versa?*

Fig. 15 shows the variation of the external moment with the outside flange diameter (or flange width) according to the above formulas and tests. In the investigation the bolt circle and the outside diameter of the flange was reduced or increased by the same amount. It is of interest to note that the strength of hubbed flanges increases with the outside diameter, even when the diameter of the bolt circle is increased the same amount as the outside diameter.

A comparison between Figs. 6 and 15 shows that the increase

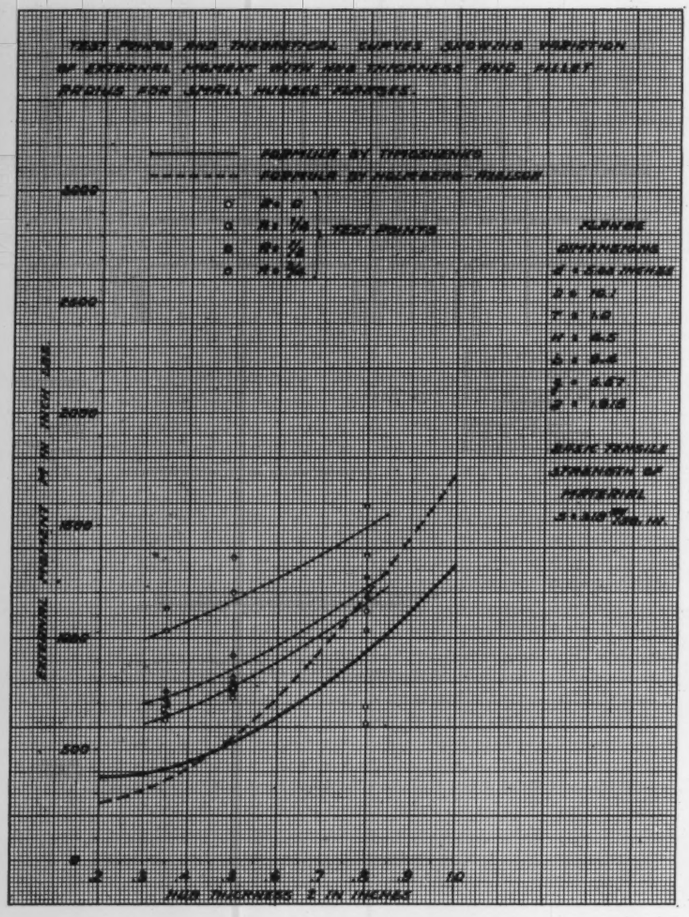


Fig. 13—Test points and theoretical curves showing variation of external moment with hub thickness and fillet radius for small hubbed flanges

Flange dimensions (in inches) —*d*, 5.05; *D*, 10.1; *T*, 1.0; *H*, 4.5; *b*, 9.4; *g*, 5.57; *a*, 1.915. Basic tensile strength of material, *S*, 318 lb per sq in.

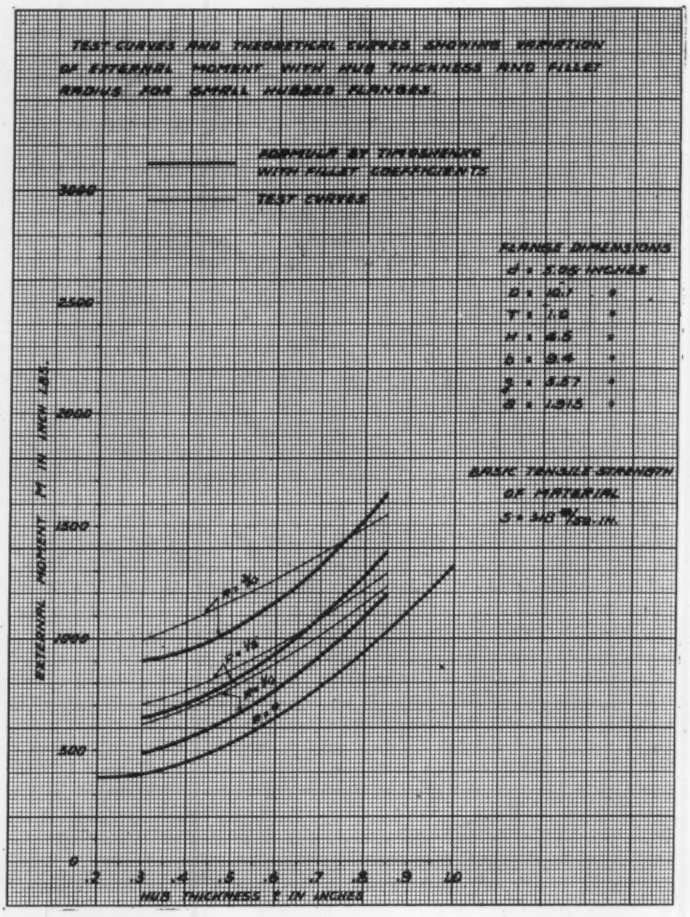

FORMULA BY TIMOSHENKO WITH FILLET COEFFICIENTS
TEST CURVES
FLANGE DIMENSIONS
BASIC TENSILE STRENGTH OF MATERIAL
EXTERNAL MOMENT M IN INCH LBS.
HUB THICKNESS t IN INCHES

Fig. 14—Test curves and theoretical curves showing variation of external moment with hub thickness and fillet radius for small hubbed flanges

Flange dimensions (in inches) —*d*, 5.05; *D*, 10.1; *T*, 1.0; *H*, 4.5; *b*, 9.4; *g*, 5.57; *a*, 1.915. Basic tensile strength of material, *S*, 318 lb per sq in.

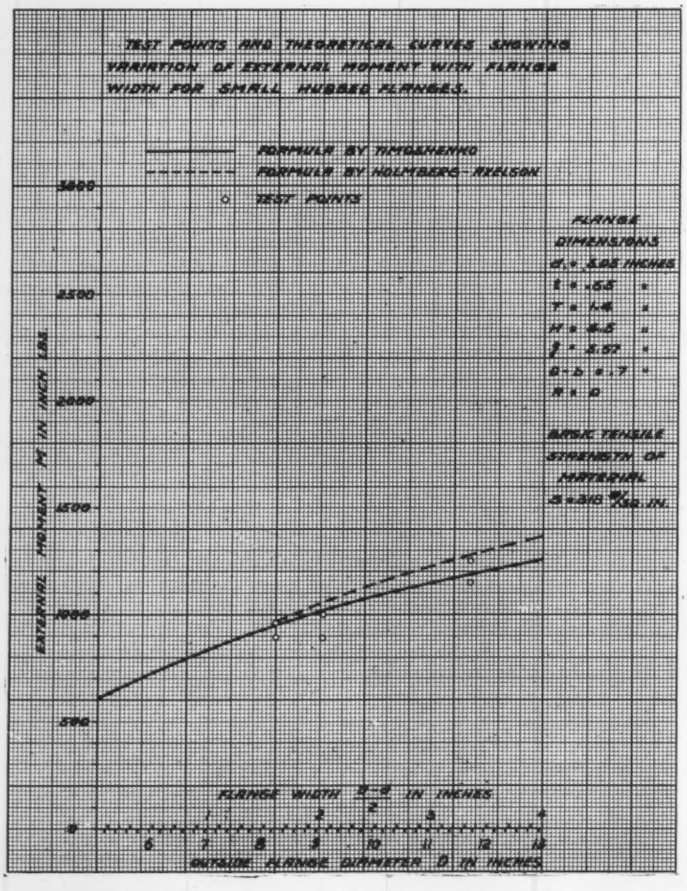

FORMULA BY TIMOSHENKO
FORMULA BY HOLMBERG-HELLSON
TEST POINTS
FLANGE DIMENSIONS
BASIC TENSILE STRENGTH OF MATERIAL
EXTERNAL MOMENT M IN INCH LBS.
FLANGE WIDTH g-d/2 IN INCHES
OUTSIDE FLANGE DIAMETER D IN INCHES

Fig. 15—Test points and theoretical curves showing variation of external moment with flange width for small hubbed flanges

Flange dimensions (in inches) —*d*, 5.05; *t*, 0.65; *T*, 1.4, *H*, 4.5; *g*, 5.57; *D*—*b*, 0.7; *R*, 0. Basic tensile strength of material, *S*, 318 lb per sq in.

of the strength with the outside diameter for hubbed flanges is considerably smaller than for ring flanges.

Since the strength of hubbed flanges increases much faster with the flange thickness than with the flange width, the most economical design is evidently flanges with small flange width and large flange thickness.

Influence of Bolt Holes on Strength of Hubbed Flanges

In order to establish the effect of the bolt holes on the strength of hubbed flanges a few of the smaller hubbed flanges were provided with a comparatively larger number of large bolt holes. The test results of these flanges will be tabulated in Appendix 2 and a comparison with the other test results shows that the influence of the bolt holes on the strength of hubbed flanges is practically negligible.

Influence of Hub Length on Strength of Hubbed Flanges

In order to establish the influence of the hub length on the strength of hubbed flanges, two large flanges with a hub length considerably shorter than the minimum hub length calculated from Formula 26 have been tested. A comparison with the other test results shows that the influence of the hub length is of minor importance within the practical range of hub lengths used in hubbed flanges. These test results are not included in the report.

Summary

As a summary of this investigation of hubbed flanges it can be stated that:

The formula for hubbed flanges and the fillet coefficients given are all reliable for engineering purposes.

Keeping rigidly to the theory of elasticity, it might be said that the Holmberg-Axelson formulas are precise in their development. The Timoshenko formula is made more simple by making certain assumptions with regard to the deflection. For the particular types of hubbed flanges investigated it can be said that the test results generally are in good conformity with Formula 25, which, together with the fillet coefficients given in Table 1 or Fig. 8, represents a comparatively simple method of determining the strength of hubbed flanges.

Evidently the formulas can be used with the same accuracy in determination of the stress for given external load and dimensions, since the stress is directly proportional to the external load.

[*To be continued*]

Air Conditioned Hospital—

[*Concluded from page* 24]

demanded for others, it would have to be possible to vary the humidity within the rooms. As a consequence, each room is a unit in itself and can be adjusted to suit the requirements of each patient.

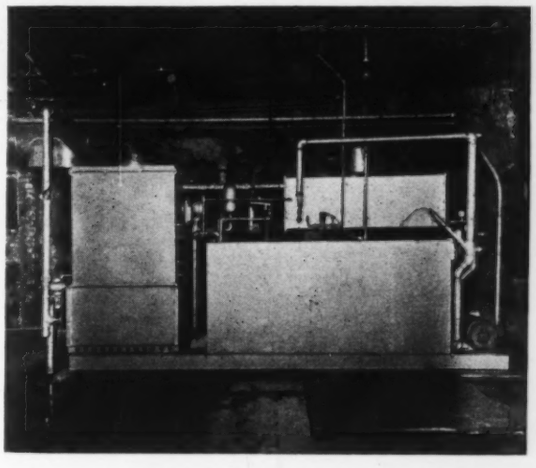
Dr. Young also stressed the advantage of having the air washed and filtered before it is brought into the room, since it not only cleans the air of dust and soot, but renders it free of pollen and other particles responsible for attacks of asthma and hay fever.

He then contrasted the conditions that can be maintained with the heat wave in the middle west last summer, when surgeons had to operate in a room at a temperature of 108 degrees. While he does not consider air conditioning a panacea, he believes it is an adjunct to treatment making it possible to give the patient the best that is known in the way of climatic environment and adding to the patient's general comfort, thereby giving normal physiological processes better opportunity to function.

Dr. William F. Petersen, professor of pathology at the University of Illinois medical school, was the guest speaker. Famous for his research on climate and disease, which has given him an international reputation, Dr. Petersen has combined medical science and meteorology in the study of climatic conditions, and thereby has introduced new facts of great value to both the medical and engineering professions.

He showed that the death rate in various cities throughout the United States increases or decreases as climatic changes occur. He said that the reason this completely air conditioned hospital was built in New England was due to the fact that a great demand for it was there. Dr. Petersen exhibited a storm map of the United States which showed that New England is directly in the path of storms sweeping both from the east and the north. He said that diseases such as colds and pneumonia always increase during unstable barometric periods, and, as the weather reaches a more stable condition, the number of infections and the death rate decreases.

The same is true of surgical mortality, high blood pressure cases and many diseases, he said. By such



Lithium chloride tank (right, below); boiler (left); and the economizer (right, above)

conditions as can now be brought about in the Corey Hill Hospital, it is possible to shield the patients from these destructive forces, and thereby not only give them greater expectancy of recovery, but expectancy of more rapid recovery.

There followed discussions of Dr. Petersen's address by Prof. C. P. Yaglou of the Harvard School of Public Health, who commented on the present status of hospital air conditioning and by Dr. Samuel A. Levine of the Harvard Medical School. The latter confined his discussion largely to what is known about patients suffering from rheumatic fever and heart diseases, mentioning that children afflicted with rheumatic fever fare better when they leave Boston and go south for the winter period; on their return, if the weather is inclement, they again become ill. He hoped that as a consequence of facilities such as offered by the Corey Hill Hospital, that patients would not have to be sent away from home in order to derive the benefits of the proper climate. He also discussed the detrimental effects of cold and inclement weather on patients suffering from angina pectoris and other heart trouble.

[A description of the engineering details of this installation is planned for publication in a later issue.]

WHAT AIR CONDITIONING MEANS TO THE RETAILER

By **Verda Jensen***

ALTHOUGH drug store air conditioning at present lags behind air conditioning of certain other retail establishments, notably restaurants and specialty stores, the next few years should see much activity in the entire retail drug field. Druggists are exhibiting wide interest in air conditioning as a definite, required factor in store modernization. And more drug stores are being modernized now than in many years, for owners know a modern store means increased efficiency of operation, added profits and more customers. Large drug chain outfits, having available capital to invest in their store units, generally take the initial steps in modern store design, increased soda fountain and lighting facilities, new store fronts, equipment and air conditioning.

Such activity on the part of chain outfits forces the smaller independent merchant to follow suit as promptly as he can. The druggist is reasonably quick and willing to respond to any devices which will increase his business. He is accustomed to lively competition, for not only does he vie with other drug stores—and there are always plenty of them—but he competes with restaurants through his soda fountain and general stores with much of his other merchandise. His interest, then, in air conditioning as a weapon to fight competition, build his business, add customers and boost sales volume is genuine, for he is aware of the need for a completely modern business if he is to be successful.

The trend in air conditioning in the drug field shows, for the most part, that the first installations are made by large chain store units, followed later by large local chains, then large independent stores, and working down gradually toward the small neighborhood retailer to whom, as yet, air conditioning is a convenience and not a growing business necessity.

Illustrating this, of the 37 air conditioned drug stores now in Chicago (which city leads the field in drug store air conditioning), 16 installations are in stores operated by two national chain organizations, 13 are in local chain units (organizations with three and more stores), and only eight in strictly independent stores. Thirteen stores had installed air conditioning in 1936 up to December 1. In 1935, there were 14 installations. The figures also show, however, that last year there were more independent stores buying air conditioning as compared with previous years, when it was confined almost entirely to national and local chains.

There is no doubt but that druggists are fully aware of the benefits of air conditioning, and that they will turn to it as soon as the investment is possible. A typical drug store installation was discussed at length in a midsummer issue of *American Druggist,* in which the air conditioning in a Sutliff & Case drug store, Peoria, Ill., was surveyed. The installation was completed in the middle of July, 1935. Sales figures for that month jumped immediately to a new high, being 12 per cent above July, 1934, and the installation was in use only one-half of the month. August figures were even more gratifying, showing an increase of 21 per cent over the previous August. These figures, it should be noted, come from a large store with a high daily sales volume, so an increase of 21 per cent amounts to a substantial figure. Air conditioning undoubtedly deserves much of the credit.

Some of the most apparent results of an air conditioning installation in a drug store include increased traffic flow (most important to the druggist, who depends on quantity sales), increase in size of individual sales, and a higher gross volume of business. Employee efficiency is a major factor, too, especially at the soda fountain where rapid service — leading to frequent breakage of equipment, especially in hot weather—plays a big part in fountain operation. In air conditioned drug stores, the fountain trade seems to benefit first and to the greatest extent. Checks mount steadily; where a soft drink was ordered before, a sandwich luncheon with a malted milk now replaces it. The peak luncheon load, formerly from 11:30 until 1:30, extends, after the store is air conditioned, from 11 to 3, and there is not much slack in business after that.

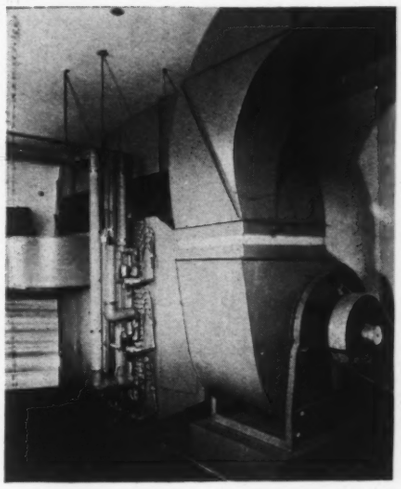
Customers drop in at the store to purchase something, find the cool interior such a relief that they linger to shop around, often leaving much later with several bundles of items. Employees sell more merchandise; they are not exhausted, uncomfortable or irritable, from the heat. Customers, likewise, are in better humor, more receptive and in no hurry to leave the store. They listen patiently to many a sales solicitation they would have walked out on before.

The drug store air conditioning installation must combine the functions of those of department store and restaurant because, in effect, that is what the requirements of the average drug store amount to. The system must provide sufficient ventilation to remove smoke and cooking odors from the air; and plenty of cooling to accommodate a comparatively high number of persons in the store—employees and customers, with the latter constantly entering or leaving the store—several large plate glass windows, steam tables, toasters, grills, coffee urns and numerous electrical and gas devices. For these reasons, drug store installations often cost more than the druggist

*Writer on the retail drug field.

anticipates and frequently demand additional selling effort and explanation.

At the Sutliff & Case drug store referred to above, special mention was made of the value of their cooling system in keeping perishable stock through the hot summer season. Where formerly they had found it necessary to reduce their stock of chocolate candy to a minimum and to cut down on certain lipsticks and creams in their cosmetic department which tended to liquefy at high summer temperatures, after air conditioning they are able to maintain their stock in such merchandise at the high winter level all year 'round. Food spoilage at the soda fountain has been reduced, and the absence of gnats and flies is of great benefit to fountain operating costs, where rolls, cakes, pastries and fruits exposed on the counter had had to be discarded because of their attraction for flies and gnats.



Because of air filtering, the need of dusting merchandise, shelves, counters and store furnishings has been reduced. Before installing air conditioning, it was necessary to keep an employee at work almost all the time keeping the stock clean from dust and dirt which accumulated in the store. So effective are the results of the filtering system that the store operates this portion of its air conditioning equipment during the entire year.

Air conditioning means—in many ways—increased profits to retail businesses. The reasons for and benefits from air conditioning drug stores outlined in this review have their parallels in practically every other retail field. The air conditioning of commercial buildings is expected to be the most active application this year. Above is a view of the air conditioning equipment serving the modernized Thrifty drug store, Los Angeles. (Photo, York Ice Mchry. Corp.)

Research—

[*Concluded from page* 42]

obtain satisfactory results, which has increased installation costs and the amount of service after the installation has been completed.

To correct this situation, a constant series of investigations is being conducted to determine the best and most simple system of controls for each desired result. When this experimental work has been completed, standard layouts of all types of mechanical equipment will be made available which will permit the application of automatic controls in the best manner.

Actually, therefore, the conditioning system may be designed around the control system and it is believed that greatly improved results will be obtained when this vital part of any air conditioning system is given more careful consideration. Standardization of control applications through the use of typical central control panel boards will undoubtedly simplify the installation as well as to permit the carrying of more complete local stocks of control equipment for quick delivery. Automatic change-over between the heating and cooling cycles will also be given special consideration as it is believed that no system can be considered as completely automatic if any manual attention is required other than the starting and stopping of the fans.

Comfort Zone Determinations

Since Minneapolis has temperatures varying from 35 F below zero in winter to 106 F above zero in summer, this installation offers an excellent opportunity to make a thorough investigation of the comfort zones in the northern portion of the country. Although this investigation has not yet been started, it is intended to select about fifty from the personnel in the conditioned space and to obtain their reactions to a definite schedule of temperatures and relative humidities over a period of several months in both summer and winter.

Air Distribution and Air Filtration

With the comfort zone determination, a number of experiments will be conducted in the distribution of the conditioned air. All of the various types of discharge grilles will be used and a careful check made of the results with particular emphasis on the effect of air movement on human comfort.

All known types of filters are to be tested in order to compare the efficiency and economy of each type.

Other miscellaneous investigations will be conducted at the request of engineers, manufacturers, etc.

Plant Motor Survey Pays

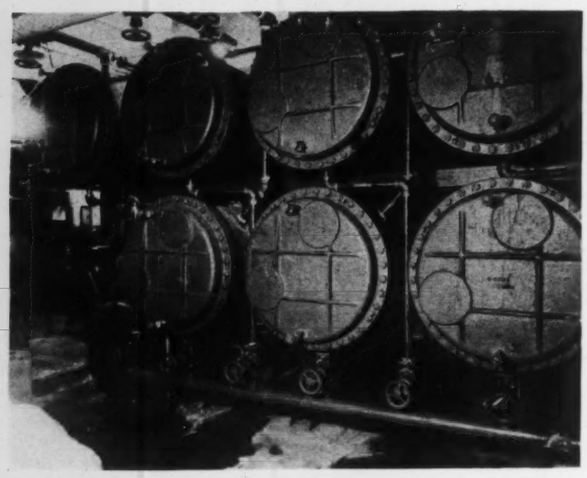
How valuable a survey of plant electrical conditions may be is exemplified by the findings of R. C. Hodges of the Titanium Pigment Co., Sayreville, N. J., who recently made load tests on 800 motors. Many were overloaded. For example, the same hp-size motor previously satisfactory on a low speed pump had been put on a higher speed pump of the same size. Other motors were underloaded with resultant poor efficiency and power factor.

About 90 per cent of the tests were made without breaking circuits, yet only simple testing equipment was used—two ammeters, a voltmeter, a volt-ammeter, a recording ammeter, and two current transformers.

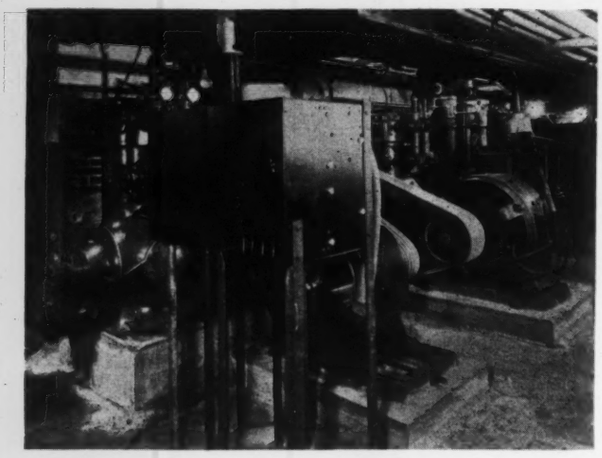
Besides using instruments for motor load tests, Mr. Hodges also puts them to work frequently to check unusual conditions. For example, a motor driving a vacuum pump tripped out. Tests showed the motor was all right, the pump at fault. Again, when a transformer overloaded, a recorder traced the causes to a heater and a gang of electric ovens. In many instances, too, instruments are permanently installed on motors, such as on those driving agitators, enabling operators to keep mixtures at the proper consistencies.—R. W. Orth.*

*General Electric Co., Schenectady, N. Y.

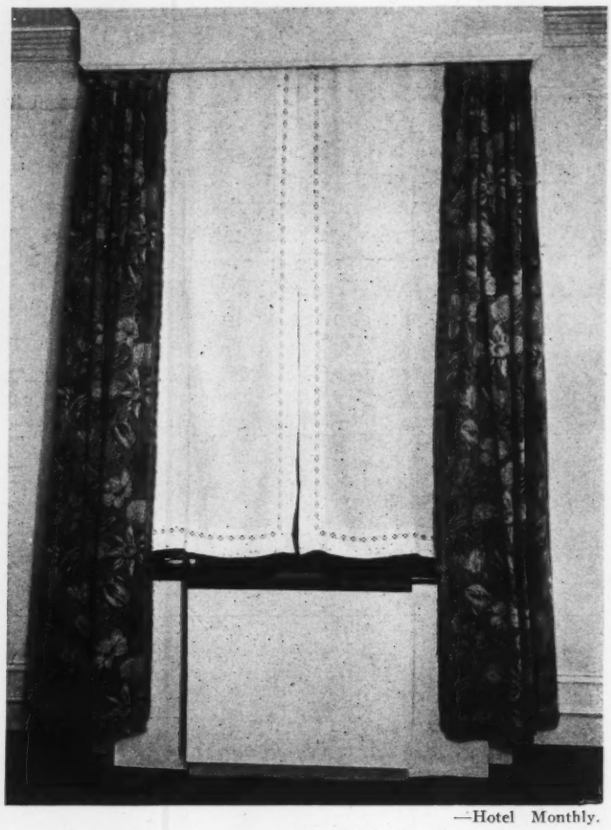
Statler Service at St. Louis Includes Air Conditioned Guest Rooms



A view of the condensers



Two 75 ton and one 100 ton ammonia compressors for air conditioning at the Hotel Statler



—Hotel Monthly.

Attractive appearance of individual room unit

IT is quite appropriate that the headquarters of the *American Society of Heating and Ventilating Engineer's* annual meeting later this month will be the Hotel Statler, St. Louis, for this hotel placed in service last year one of the most extensive installations for cooling guest rooms which has been made to date. There are some 224 individual room units supplied with chilled water from a central refrigerating plant for cooling 224 rooms facing the street; 89 rooms on the courts are supplied by three duct systems.

The water is chilled by direct expansion ammonia. The water circulating pumps and coolers are in the sub-basement and the distributing piping is situated in a service floor 67 ft above basement. Immediately above this service floor is the first sample floor which is cooled. In all, eight floors are conditioned, and it was possible to run the risers straight up to the topmost floor, with the exception of one offset. The total vertical distance between the circulating pump in the sub-basement and the highest units on the eighth floor is 134 ft. The water circulating system is "balanced"—that is, frictional resistance only must be overcome by the pump. Total frictional resistance of the piping, cooling unit, and water cooler is about 50 ft. The water circulation has been found to be perfect, and no adjustments were required, although valves are provided for adjusting the water flow.

Each room cooling unit comprises a frame-work upon which is mounted the cooling coils and the motor driven fan. All piping and wiring to the unit is concealed in sheet metal channels extending from floor to ceiling and hidden by the drapes as illustrated. The left channel encloses an insulated chilled water supply line and two BX cables conveying energy to the fan motor; the right channel contains the cold water return piping and the condensation drain. The guest may control the fan speed of the unit serving his room, as well as the amount of outside air introduced. Thermometers mounted on the top of each unit show inside and outside temperatures.

The consulting engineer was Arthur K. Ohmes*, to whom we are indebted for the information given here.

*Of Tenney & Ohmes, New York, N. Y. Member of Board of Consulting and Contributing Editors.

Heating · Piping
and Air Conditioning

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

JOURNAL SECTION

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Heat Losses and Efficiencies of Fuels in Residential Heating

By R. A. Sherman* (*MEMBER*) and R. C. Cross** (*NON-MEMBER*), Columbus, Ohio

OF the several factors that govern the choice of a fuel or the furnace or boiler in which it is burned for residential heating, the efficiency is by no means the most important. Heating satisfaction, which includes dependability, convenience, cleanliness, and quietness, is generally the determining factor that governs the choice of a fuel. If there is a choice between fuels, or if it is desired to weigh carefully the merits of the fuels in relation to their costs, efficiency should be considered, for it is not the cost of the heat in the fuel purchased but the cost of the heat delivered to the residence that should be compared.

Many laboratory determinations of the efficiency of various fuels in different types of heating equipment have been made. These have been valuable for the determination of the optimum values that can be obtained under correct and carefully controlled test conditions, but the possibility has always existed that the data were not applicable to actual residential operating conditions. Fuel tests conducted at the University of Illinois in the Research Residence of the *National Warm Air Heating and Air Conditioning Association* resulted in the recording of much valuable data, but in these tests the equipment was correctly installed; it was maintaind in first class condition, and the attention to the fire was under technical control. Another valuable series of tests on coal firing was that conducted by the Bureau of Mines and published in a previous bulletin.[1] However, in these tests the equipment and conduct of the investigations were also under technical direction, and as a result, the performance obtained was probably better than that of customary operation.

A distinct need has existed, therefore, for data on the extent of the heat losses in the use of various fuels for residential heating. This need was partly filled by an extensive survey[2] of the performance of oil burners in residences in Madison, Wis. The purpose of the present investigation, which was sponsored by Bituminous Coal Research, Inc., was to obtain this same type of information for various types of fuels and various types of heating equipment.

Fig. 1—Typical houses used in tests

Scope of Investigation

The investigation consisted of a series of tests on the heating plants of 15 homes located in Columbus, Ohio, during the 1935-36 heating season. The fuels included bituminous and semi-bituminous coals, by-product coke, natural gas, and oil burned in warm-air furnaces and hot-water and steam boilers.

A few of the houses included in the test program are illustrated in Fig. 1. They were homes of 7 to 14 rooms, occupied by families of 2 to 7 persons, and considered to be typical of homes of this class in any part of the country.

[1] Five Hundred Tests of Various Coals in House-Heating Boilers, P. Nicholls, S. B. Flagg and C. E. Augustine, Bureau of Mines Bulletin 278, 1928.

[2] Oil Burning in Residences, D. W. Nelson, A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, July 1935.

* Fuel Engineer, Battelle Memorial Institute.
** Fuel Engineer, Battelle Memorial Institute.

For presentation at the 43rd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, St. Louis, Mo., January, 1937.

Method of Investigation

Test Procedure

The test on each heating plant was normally of 123 hours' duration, from 6 a. m. Monday to 9 a. m. Saturday, during which period observers were present from 6 a. m. to 10 p. m. The data recorded included the weight of fuel charged and of ash and refuse removed, the frequency and time of attention to the plant, the temperature of the air and of the flue gases, the composition of the flue gases, density of smoke, and the drafts. A recorder in the living quarters of the house recorded the temperature, humidity, and the operating intervals of stokers and oil burners. A watt-hour meter was used to determine the power consumption of stokers and oil burners. A gas meter was connected into the line to the furnace on gas-fired installations to obtain the amount of gas used.

An installation of the test equipment on a warm-air furnace is shown in Fig. 2. The apparatus was made compact and portable so that it could readily be moved from one house to another.

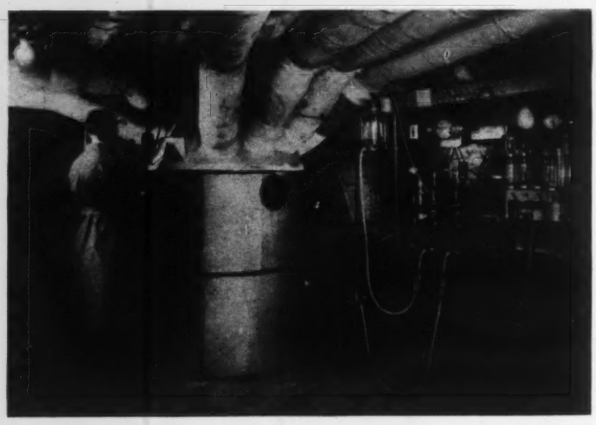

Fig. 2—Arrangement of test equipment

An attempt was made in these tests to obtain normal operation of the heating equipment so that the results would be representative of normal practice. The householder fired the furnace, adjusted the dampers, set the thermostat in accordance with his comfort standards, and the observer merely recorded the results obtained. At the end of each test the householder was advised of changes which could be made in his firing practice or adjustment of the stoker or burner to improve the results.

Calculation of Efficiencies

When a boiler or furnace is tested in the laboratory the amount of heat utilized is usually determined directly. That is, in a hot water boiler, the weight of water circulated through the boiler and its rise in temperature are measured; in a steam boiler, the weight of water evaporated and the temperature and pressure of the steam are determined; in a warm-air furnace, the weight of air and its rise in temperature are found. These methods were not available in the test houses. Therefore, it was necessary to determine the amount of the various losses of heat and obtain the efficiency by difference.

The heat losses in domestic heating that can be measured are: (1) loss in the moisture from the air, in the fuel, and that formed from the combustion of hydrogen in the fuel, (2) the sensible heat in the dry flue gases, (3) the undeveloped heat in carbon monoxide, and (4) heat in unburned carbon in the ashpit. In laboratory tests the radiation from the boiler or furnace is considered as a loss, but in these tests it was considered as useful heat as it was delivered to the house.

In addition to these losses, however, there is always an item of *unaccounted-for loss,* which is generally due to unburned hydrocarbons and soot which are not ordinarily determinable. Inasmuch as this loss is often an appreciable fraction of the heat input, it was obvious that the efficiencies could not be taken as the difference between the heat input and the determined losses. From several available sources values for *unaccounted-for losses* were selected and added to the determined losses before calculation of the heat utilized, or efficiency, by difference. The values assumed and the basis for their selection are discussed under each group in the presentation of the results.

Although the values obtainable by these methods cannot be considered to have the accuracy of tests under laboratory conditions, and although it was impossible to cover enough of each type to arrive at true averages, yet the fact that the data obtained were from truly typically maintained and operated home heating plants is believed to outweigh the limitations in accuracy.

Discussion of Data

Tables 1 to 4 present the principal data obtained from the tests of the 15 heating plants; each table includes the tests of one method of firing. The data are much abridged from the total data taken, but the most significant data are given and many are included that are not discussed, which may be of additional interest or value. The general indications are summarized at the end of the discussion of each fuel and method of firing, and the overall conclusions are summarized at the close of the paper.

Bituminous Coal, Hand-fired

Table 1 presents the results of the tests of the three heating plants which burned bituminous coal fired by hand; two were warm-air furnaces and the third a steam boiler. All three were typical installations of their kind with the exception that all were equipped with thermostatic controls; that of Case 32 had a *high-limit* control based on the expansion of a copper pipe in the bonnet and the steam boiler had the usual limit control actuated by the boiler pressure, but the furnace of Case 13 had no limit control.

Both Case 13 and Case 26 used low-ash, lump coal, whereas Case 32 used 2 in. screenings which had a higher ash content.

The average CO_2 content of the flue gases was similar for Cases 13 and 26. However, the weight of dry flue gases per pound of coal, from which the dry flue gas loss is calculated, was higher for Case 26; this apparent discrepancy results from the fact that the gas composition re-

Table 1—Performance Data

Hand Fired Plants

Item No.		Group 1 Bituminous Coal		Group 2 Semi-Bituminous Coal			Group 3 Coke	
	General Information							
1	Case number	13	26	32	14	4	1	Wood
2	Type of house	Brick	Brick	Wood	Wood	Brick	Brick	9
3	Number of rooms	7	9	8	7	8	8	2
4	Maximum design heat loss of building—Btu per hr	71,156	95,319	69,589	88,816	84,924	83,261	77,807
5	Type of heating system	Warm Air	Steam	Warm Air	Warm Air	Warm Air	Warm Air	Warm Air
6	Leader area—sq. in.	565	...	712	770	623	772	791
7	Radiation—sq ft	...	448	...	...	...	...	.
8	Date of test	Nov. 18-23, '35	Feb. 17-22, '36	Mar. 9-14, '36	Jan. 6-11, '36	Feb. 10-15, '36	Oct.28-Nov.2,'35	Jan. 20-25, '36
9	Duration of test—hrs	121.5	123	122	122	123	120	122
10	Degree-days in test period	137	266	113	150	219	29	294
11	Average daily mean temperature—F	36	14	43	36	21	59	8
	Fuel							
12	Kind	Eastern Ky	W. Va.	Ohio	Semi-bit.	Semi-bit.	Coke	Coke
13	Size	Lump	Lump	2" screenings	Lump	Lump	Nut	Stove & Nut
	Proximate analysis, as fired, per cent							
14	Volatile matter	33.4	32.0	33.6	23.7	15.7	1.1	1.2
15	Fixed carbon	60.0	63.0	50.9	71.2	74.4	90.3	90.3
16	Ash	3.6	3.5	7.5	3.1	6.6	7.8	7.7
17	Moisture	3.0	1.5	8.0	2.0	3.3	0.8	0.8
18	Sulphur	0.6	0.5	2.2	0.6	0.7	0.6	0.7
19	Calorific value, Btu per lb	14,143	14,681	11,928	14,942	14,313	12,395	12,332
20	Total fuel fired—lb	429	867.25	440.25	425.5	667	171.25	676.5
	Drafts							
21	Draft in furnace—in. water	0.016	0.060	0.071	0.025	0.069	0.025	0.018
22	Draft at smokehood—in. water	0.016	0.046	0.068	0.042	0.074	0.017	0.013
	Flue Gases							
23	CO_2—per cent	7.8	7.8	4.0	6.0	5.7	6.4	10.3
24	O_2—per cent	11.2	11.2	16.0	13.7	13.9	13.7	9.9
25	CO—per cent	0.6	0.2	0.1	0.1	0.1	0.3	0.3
26	N_2—per cent	80.4	80.8	79.9	80.2	80.3	79.6	79.5
27	Dry flue gas per lb of fuel—lb	26.18	33.27	47.75	37.44	36.78	33.7	21.52
28	Excess air—per cent	105	108.5	310	182	188.5	182	86.7
	Temperatures							
29	Flue gases—F	454	574	363	428	463	219	475
30	House living quarters—F	73	74	71	68	72	72	68
31	House living quarters—relative humidity—per cent	40	28	50	43	26	58	30
	Hourly Rates							
32	Fuel fired—lb per hr	3.53	7.04	3.61	3.54	5.43	1.43	5.54
33	Heat input—Btu per hr	49,925	103,354	43,060	52,895	77,719	17,725	63,319
34	Fuel fired—lb per sq ft grate per hr	1.33	1.65	1.25	1.47	2.05	.38	1.39
	Smoke							
35	Average density—Ringelmann number	0 to 1	1	0	0	0	0	0
	Attendance							
36	Total number times attention to fire per day	5	6	4	11	4	2	5
	Heat Balance—Per Cent							
37	Losses due to moisture	4.7	4.6	5.9	4.0	4.0	0.7	0.7
38	Loss due to heat in dry flue gases	16.8	27.8	27.6	21.5	24.4	9.6	17.0
39	Loss due to carbon monoxide	4.0	1.4	1.3	0.9	1.0	3.2	2.0
40	Loss due to unconsumed carbon in ash	1.0	0.4	3.8	4.6	3.3	0.6	0.5
41	Unaccounted losses (assumed)	20.0	20.0	20.0	15.0	15.0	10.0	5.0
42	Total losses	46.5	54.2	58.6	46.0	47.7	24.1	25.2
43	Overall efficiency (by difference)	53.5	45.8	41.4	54.0	52.3	75.9	74.8
44	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

ported is the arithmetical average for the week, whereas the weight of the flue gas was calculated for each hourly period and then averaged, which is the correct method. The CO_2 content for Case 32 was much lower than the other two. This was caused by the admission of air through three pipes which the owner had placed in the furnace to admit air over the fuel bed. The air admitted may not have been excessive in periods of high rates of burning, but during the test week, which was in rather mild weather, too much secondary air was admitted.

In all three installations some unburned *CO* was found in the flue gases. This accounted for a loss of 1.3 to 4.0 per cent of the heat in the coal fired.

The losses due to unburned carbon in the ash were both very favorably low for Cases 13 and 26 but were higher for Case 32. This was accounted for by the small size of the coal fired and a broken grate in the furnace.

The loss of heat in the dry flue gases, which is the largest single item of heat loss other than the *unac-*

counted-for was 16.3 to 27.8 per cent. The higher loss for Case 26 is accounted for by the higher weight of flue gases and the higher temperature. A higher temperature was expected because of the more severe weather during the test on this installation. The high loss in Case 32 was due to the high excess of air.

Unaccounted-for Loss

The necessity for the assumption of some value for an *unaccounted-for* item which includes the undetermined losses in soot, tar, and gaseous hydrocarbons has been previously discussed. For each of these tests a value of 20 per cent has been assumed. A series of tests conducted by the Bureau of Mines on a small boiler in which the radiation was separately measured and in which the entire installation was mounted on scales to permit accurate knowledge of the amount of fuel burned gives the most authoritative data on the losses to this source. Papers[3-4] on this work indicated losses of 15 to 25 per cent which were unaccounted for. A bulletin[5] of the Mines Branch, Department of Mines, Canada, showed that unaccounted-for losses increased with the increase in the volatile matter of the coal; with coals having 30 to 35 per cent volatile matter the loss averaged 15 per cent.

The tabulation given shows a comparison of the heat balance of Case 26 with that of one of the tests[3] previously reported:

	Case 26	B. M. Test 52[a]
Heat Balance, per cent of heat in coal		
Heat utilized	45.8	53.5[b]
Losses due to moisture	4.6	4.2
Losses to heat in dry flue gases	27.8	13.5
Loss due to carbon monoxide	1.4	4.2
Loss to unburned carbon in ash	0.4	4.4
Unaccounted-for loss	20.0	20.2
	100.0	100.0
CO_2 in flue gases, average, per cent	7.8	7.1
Flue gas temperature, degree Fahrenheit	574.0	406.0
Volatile matter in coal, per cent	32.0	36.4
Fuel fired per square foot per hour	1.3	1.3

[a]Calculated to include combustible in ash loss.
[b]Includes radiation and convection losses.

These data indicate that the assumed value of 20 per cent for the unaccounted-for losses was a reasonably accurate approximation.

Summing up the various losses and deducting from 100, there remains 41 to 53 per cent of the heat in the fuel as the overall thermal efficiency or the heat delivered to the house.

Semi-Bituminous Coal, Hand-fired

Two tests were recorded on homes using semi-bituminous coal in lump size, one a medium-volatile, 23.7 per cent, and one a low-volatile, 15.7 per cent, coal. Both installations were warm-air furnaces. Neither furnace was equipped with a thermostat and the fire was attended and the dampers adjusted according to the desire of the occupants. The installations were typical, therefore, of heating plants with no automatic devices. Table 1 includes the data on these tests.

The maximum CO_2 content of the flue gases in any hour on one case was 12.4 and on the other 10.7; the minimum was as low as 1.0 per cent. The average CO_2 content for both furnaces was about 6.0 per cent, which amounts to about 180 per cent excess air. The flue-gas temperatures were similar, and the loss of heat in dry flue gases was of the same order, 21.5 and 24.4 per cent, for the two installations. The loss due to moisture was the same, 4.0 per cent, which is a normal loss. The loss due to unburned carbon monoxide was about 1.0 per cent, which was less than for the furnaces burning the high-volatile coals.

The losses due to the unburned carbon in the ashpit were 4.6 and 3.3 per cent, which were higher than those for the high-volatile coals. This is explained by the greater friability of the lower volatile coals.

The value selected for the losses in tar, soot, and gaseous hydrocarbons, the *unaccounted-for* loss, for these coals was 15.0 per cent. This value was chosen from a consideration of previously reported data[6] where the average *unaccounted-for* loss, including radiation, for coals of 15 to 25 per cent volatile matter was 13.25 per cent.

The sum of the losses amounts to 46.0 and 47.7 per cent, leaving as the efficiency of utilization of the heat in the coal 54.0 and 52.3 per cent. These values check closely with the result with high-volatile coal, Case 13, which had a similar flue-gas temperature; the lower *unaccounted-for* loss assumed for the low-volatile coals was offset by the lower loss in heat in dry flue gases because of the lower excess air with the high-volatile coal.

Coke, Hand-fired

The results of the two tests operated with furnaces burning hand-fired coke in warm-air furnaces in houses of similar size are also included in Table 1. The test on Case 1 was recorded during a week of mild weather in

[6]Loc. cit. See note 5.

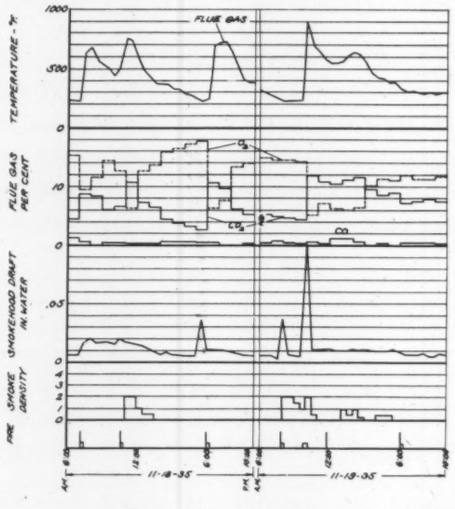

Fig. 3—Test log, Case 13, B-WA-BH

[3]Heat Transference and Combustion Tests in Small Domestic Boiler, John Blizard, W. M. Myler, Jr., J. K. Seabright and C. P. Yagloglou, A.S.H.V.E. Transactions, Vol. 29, 1923.
[4]Heat Transference and Combustion Tests in Small Domestic Boiler, H. W. Brooks, M. L. Orr, W. M. Myler, Jr. and C. A. Herbert, A.S.H.V.E. Transactions, Vol. 31, 1925.
[5]Comparative Tests of Various Fuels When Burned in a Domestic Hot Water Boiler, E. S. Malloch, and C. E. Baltzer, Canada Department of Mines, Mines Branch, 705, 1929.

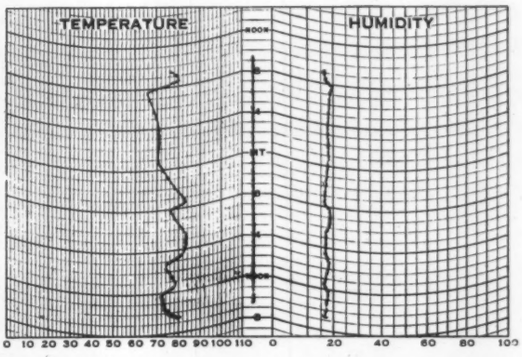

Fig. 4—House temperature record—manual control

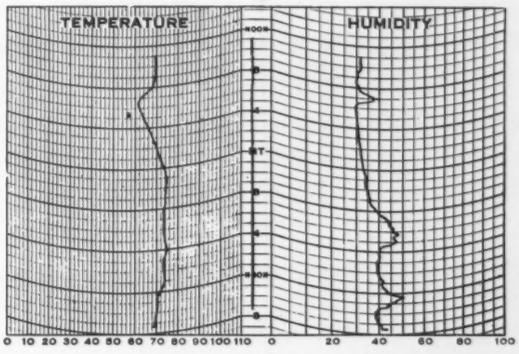

Fig. 5—House temperature record—thermostatic control

early fall and that on Case 9 during one of the most severe weeks of the winter. The furnace of Case 1 was arranged with a fan and filter unit, and both furnaces were equipped with thermostatic control and limit controls to prevent overheating of the furnace. Both installations were somewhat above the average in the order of maintenance. Also both owners had used coke for a number of years and fired it with care.

The coke used in both furnaces was by-product coke from the same source, but Case 1 used nut size whereas Case 9 used a mixture of stove and nut. The coke had a lower ash content than that frequently sold for domestic purposes; for the country as a whole the ash content of coke would probably average 9 to 10 per cent, whereas this coke contained less than 8 per cent ash.

Because of the difference in the average rates of burning, 0.38 and 1.39 lb per square foot of grate per hour, the average CO_2 contents were 6.4 and 10.3 per cent respectively. During the test on Case 9 an hourly average as high as 16.4 per cent CO_2 was found. The higher weight of flue gas per pound of fuel in Case 1 was more than compensated for by the low flue gas temperature, 219 F, so that the loss in sensible heat in the dry flue gas was 9.6 per cent as compared to 17.0 per cent for Case 9.

Because of the low content of moisture and hydrogen in the coke, the moisture losses were low, below 1 per cent, and because of the careful attention used in firing the losses due to unburned carbon in the ash were low. With both installations an average of 0.3 per cent *CO* was found in the gases which accounted for losses of 3.2 to 2.0 per cent.

Although no loss in tar, soot, or gaseous hydrocarbons is expected with coke as a fuel, some allowance must be made for *unaccounted-for* losses. A consideration of previously recorded data[7] which included tests on coke showed that at the lower rate of combustion, Case 1, a value of 10.0 per cent, and at the higher rate, Case 9, a value of 5.0 per cent would be close approximations to the correct value.

The thermal efficiencies calculated by difference after summing up the losses and using the estimated *unaccounted-for* losses amount to 75.9 and 74.8 per cent for the two cases.

General Summary of Hand-Fired Tests

Cyclic Operation. In Fig. 3 is a log of the test results recorded for two days of operation on Case 13, which burned eastern Kentucky lump coal in a warm-air furnace. The cycle of operation, that is, the increase of the smoke, of the CO_2 in the flue gases, and of the flue gas temperature after firing, followed by a gradual drop until the next firing period is typical of the results in other hand-fired tests. Although this furnace had a damper motor controlled by a room thermostat, it had no high-limit control, as has been previously mentioned. With a high-limit control to prevent the overshooting of the temperature of the furnace, the range of variations in the cycles can be materially reduced.

Effect of Thermostatic Control. A 24 hour record of the room temperature maintained in Case 4 is shown in Fig. 4 where the fire was controlled manually, and in Fig. 5 is a similar record for Case 26 where the dampers were controlled by a room thermostat supplemented by the high-limit control from the boiler pressure. The value of the thermostatic control in the maintenance of more uniform temperatures even with hand firing is clearly shown by these records.

Smoke. Smoke intensities from the stacks of these furnaces varied considerably. Except in Case 26, high-volatile coal burned in a steam boiler, where readings as high as No. 4 Ringelmann chart were noted and the stack was seldom entirely clear, the smoke intensities and periods of smoke duration were not excessive. The amount of smoke was less with the semi-bituminous coals, and obviously none was found when burning coke.

Attendance to Fire. Of the five tests in homes burning hand-fired coal, the number of trips to the basement to attend to the fire, either charging fuel, shaking grate, or stirring up the fuel bed, varied from 4 to 6, except for Case 14 where attention was given on an average of 11 times daily, including 6 times to charge fuel. As the weather was not severe during the week, this amount of attention should have been unnecessary and was due to lack of knowledge of proper methods of firing.

The attendance to the fire in the cases using coke averaged twice daily for Case 1 during the week of mild weather and 5 times daily for Case 9 during the week of very severe weather. The conclusion may be drawn, therefore, that when properly fired the attention to a coke fire may be somewhat less than to a furnace burning hand-fired bituminous coal.

Bituminous Coal, Stoker Fired

The results of the tests of the three heating plants in which bituminous coals were fired by stokers are presented in Table 2; one was a steam boiler, one was a

[7] Loc. cit. See note 3.

hot-water boiler, and the third was a warm-air furnace. The stokers of Cases 2 and 5 were typical of the common screw-feed type underfeed stokers and were designed for removal of ash as clinker; these were installed in 1932 and 1933, respectively. The stoker of Case 10, which was installed in 1929, differed from the conventional design in that it had a rotary grate around the retort which was moved by hand, thus removing a part of the ash to an ashpit as fine ash. The controls of Cases 2 and 5 included a room thermostat, a high-limit control, and a clock-driven hold-fire control. No high-limit control was provided with the stoker of Case 10.

The coals used were sized *stoker coals*, 1½x⅜ in. That used in Case 2 was an eastern Kentucky coal, and the other two used oil-treated West Virginia coal.

The flue gas from these installations was sampled continuously throughout the period of observations, but the samples were divided into the *off* and the *on* periods of operation, as previous experience had indicated that the composition differed markedly in the two periods. To obtain an overall average of the gas composition for purposes of calculation, it was necessary to have some measure of the relative amounts of coal burned in the two periods. No direct measure was had, but an approximation was made by the assumption that the rate of burning was proportional to the square root of the pressure drop across the fuel bed. With this value and the relative time of operation, the weighted averages of the gas composition and the flue-gas temperature were obtained.

Table 2—Performance Data
Stoker Fired Plants

Item No.		"On" Period	"Off" Period	Total Period	"On" Period	"Off" Period	Total Period	"On" Period	"Off" Period	Total Period
	General Information									
1	Case number		2			5			10	
2	Type of house		Brick			Brick			Wood	
3	Number of rooms		10			11			12	
4	Maximum design heat loss of building—Btu per hr.		107,324			113,234			76,655	
5	Type of heating system		Steam			Hot Water			Warm air	
6	Leader area—sq in.		...			...			846	
7	Radiation—sq ft		686			700			...	
8	Date of test		Nov. 5-10, 1935			Dec. 2-7, 1935			Jan. 27-31, 1936	
9	Duration of test—hrs		122.5			123			123	
10	Degree-days in test period		90			194			297	
11	Average daily mean temperature—F		46			28			8	
	Fuel									
12	Kind		Eastern Kentucky			West Virginia			West Virginia	
13	Size		1½" x ⅜"			1½" x ⅜"			1½" x ⅜"	
	Proximate analysis, as fired, per cent									
14	Volatile matter		33.9			35.3			36.7	
15	Fixed carbon		56.7			54.6			56.8	
16	Ash		4.9			6.8			3.9	
17	Moisture		4.5			3.3			2.6	
18	Sulphur		0.7			2.1			0.7	
19	Calorific value, Btu per lb.		13,407			13,615			14,160	
20	Total fuel fired—lb			348.5			1038.25			1202.5
	Drafts and Pressures									
21	Stoker windbox pressure—in. water	0.099	0.054	....	0.564	0.032	...	0.990	0.0	....
22	Draft in furnace—in. water	0.086	0.067	....	0.029	0.041	...	0.164	0.155	....
23	Draft at smokehood—in. water	0.088	0.063	....	0.026	0.031	...	0.189	0.180	....
	Flue Gases									
24	CO_2—per cent	6.9	3.5	5.3	9.4	7.7	9.3	7.8	6.4	6.9
25	O_2—per cent	12.2	16.5	14.3	9.1	10.6	9.4	11.3	13.6	12.4
26	CO—per cent	0.3	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0
27	N_2—per cent	80.6	80.0	80.4	81.3	81.5	81.1	80.9	81.0	81.7
28	Dry flue gas per lb of fuel—lb.	30.0	55.1	41.8	21.9	25.8	22.4	27.0	33.3	30.1
29	Excess air—per cent	30.7	357.0	206.5	72.3	95.5	76.8	113.0	174.7	135.8
	Temperatures									
30	Flue gases—F	437	268	358	934	430	882	786	720	749
31	House living quarters—F			72			75			72
32	House living quarters—relative humidity—per cent.			51			22			26
	Hourly Rates									
33	Fuel fired (average) per hr.			2.84			8.44			9.78
34	Heat input (average)—Btu per hr			38,076			114,911			138,485
	Smoke									
35	Average density—Ringelmann number	0	0 to 4	...	...	...	...	0 to 1	0 to 2	—
	Attendance									
36	Total number times attention to stoker per day.			4			2			2
	Stoker Operation									
37	Average length "On" period—Min.	7.8			29.5			22.8		
38	Average length "Off" period—Min.		47.4			36.6			87.0	
	Power									
39	Total power—kwhr			2.7			9.2			11.3
40	Power per ton of coal fired—kwhr			15.5			17.7			18.8
	Heat Balance—Per Cent									
41	Losses due to moisture			4.9			5.4			5.0
42	Loss due to heat in dry flue gases			21.1			32.3			34.7
43	Loss due to carbon monoxide			0.0			1.2			0.0
44	Loss due to unconsumed carbon in ash			0.0			0.0			0.3
45	Unaccounted losses (assumed)			5.0			5.0			5.0
46	Total losses			31.0			43.9			45.0
47	Overall efficiency (by difference)			69.0			56.1			55.0
48	Total			100.0			100.0			100.0

The boiler of Case 2 had a rectangular fire box in which the stoker retort was installed near the front; the feed tube entered diagonally from the side of the boiler near the rear. Due to the characteristics of the coal or the stoker, or both, the coal fed principally to the rear of the retort, often leaving bare tuyeres at the front. The coal tended to coke into spires which would fall away from the retort; unless they were manually pulled back into the retort at intervals, they would not burn. The operator made a practice of leveling the fire in this way two to three times a day.

The weather during the week of the test on this installation was very mild, and the ratio of *on* to *off* operation was about 1 to 6, the stoker operating principally as demanded by the hourly operation of the hold-fire control. Although the CO_2 averaged about 7 per cent during the *on* periods, owing to the long *off* periods and the fact that the furnace draft was higher than it should have been, the overall average was only 5.3 per cent, or over 200 per cent excess air. Although a small amount of *CO* was found during *on* periods of operation, the average was so low that no loss resulted from this cause. No combustible was found in the refuse which was removed as clinker, and, therefore, no loss resulted. The boiler had a comparatively large heat-absorbing surface, and the flue-gas temperatures were, therefore, favorably low despite the high excess of air. The loss due to sensible heat in the dry flue gases was 21.1 per cent.

Because of the proximity of the surrounding surfaces in the round boiler of Case 5, any coke spires that were formed fell back into the fire, and without attention to the fuel bed other than at the times of removing clinker the fuel bed remained in good condition. This is evidenced by the higher CO_2 content of the flue gases in both the *on* and *off* periods. As the ratio of the periods, because of the colder weather and the characteristics of the plant, was about 1 to 1, and the furnace draft was maintained at a low value, the overall average CO_2 was 9.3, which was equivalent to about 77 per cent excess air.

No loss was found in combustible in the refuse, and only a small amount because of carbon monoxide in the flue gases, but the performance of the boiler and stoker was limited owing to the high flue-gas temperatures. These averaged 934 F for the *on* periods and for the entire test 882 F. The boiler had only one intermediate section; if it had had more intermediate sections, much more favorable efficiency would have been obtained.

The stoker of Case 10 operated differently from the other two in that combustion must have taken place from air entering through the perforated grate around the retort as well as through the retort by natural draft during the *off* periods. The furnace draft during the *off* periods averaged 0.155 in. of water, which is about three times that commonly accepted as good practice, and the ratio of *on* to *off* time was 1 to 3 as compared to 1 to 1 for Case 5, although the weather during the test period was much more severe.

The average CO_2 for the entire test was 6.9, corresponding to 136 per cent excess air. No *CO* was found, and the loss due to combustible in the ashpit was less than 1 per cent. The flue-gas temperatures were much higher in both the *off* and the *on* periods than they should have been, which shows that the heat-absorbing surface of the furnace was too small. This resulted in a loss due to sensible heat in the dry flue gases of about 35 per cent.

No published heat balances of small stokers in domestic boilers are available from which information could be obtained on the expected *unaccounted-for* loss. However, data from tests of stokers of similar nature now being conducted in the laboratory of the Institute indicate that 5 per cent of the heat in the coal might be lost in such unaccountable items as fly carbon, soot, and hydrocarbons, and this value was assumed.

The overall efficiencies were 69 per cent for the boiler tested during the extremely mild weather and 55 and 56 per cent for the installations tested during the colder weather, when the various losses were deducted from 100.

General Summary of Stoker-fired Tests

Relation of Stoker to Boiler or Furnace. Except for Case 2, the efficiencies obtained in these tests were less than have been assumed to be obtained with small stokers. Although the number tested was too small to draw any broad general conclusions that the performance of all others is of similar order, yet these three picked at random are doubtless typical of many installations.

The relatively good efficiency of Case 2 was due largely to the ample heat-absorbing surface of the boiler and was obtained at the expense of more frequent attention to the fire, to level it off, than should have been required. The stoker was definitely at fault in not giving uniform distribution of the fuel, and the installation was at fault in not so confining the hearth that the coke formations would necessarily fall back into the retort.

The low efficiencies of the other two installations were principally due to the lack of surface to absorb the heat efficiently at the rate at which it was liberated. Both the boiler and the furnace were designed primarily for hand-firing where the rates of combustion, except for short periods in the morning, are of the order of perhaps 6 to 10 lb of coal per hour. These stokers burned during *on* periods at 20 to 30 lb per hour, and the surfaces could not absorb the heat at that rate.

Previous reports[8] on stokers which burn anthracite have shown that efficiencies of 70 per cent could be obtained in a boiler designed for stoker use, whereas about 63 per cent was the maximum that could be obtained with the stoker installed in a boiler designed for hand-firing.

Smoke. Because of the open check draft on Case 5, used to reduce the furnace draft, any smoke produced was so diluted with air that no readings were taken. On Case 2, no smoke greater than No. 1 and on Case 10 none greater than No. 2 Ringelmann chart was observed; this was much lighter than on the hand-fired tests of high-volatile coal.

Uniformity of Temperatures. A typical example of the type of regulation of room temperature obtained with the stoker on Case 5 is shown in Fig. 6. The temperature was held during the day to within 2 F. The marks in the center of the chart indicate times of operation of the stoker; the correlation between the temperature of the room and the operation of the stoker can readily be seen.

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[8]Performance Expectancy of Domestic Underfeed Stokers for Anthracite, Allen J. Johnson, Transactions, *A.I.M.E.*, Coal Division, Vol. 119, 1936.

Attendance to Fire. The necessity for attention to the fire on Case 2, because of the improper design of the stoker hearth, has been mentioned. Attention was given the others but twice each day, to fill the hopper and remove clinker, during the test periods; once per day would normally have been enough. This is contrasted with the number of 4 to 11 times per day for the hand-fired installations.

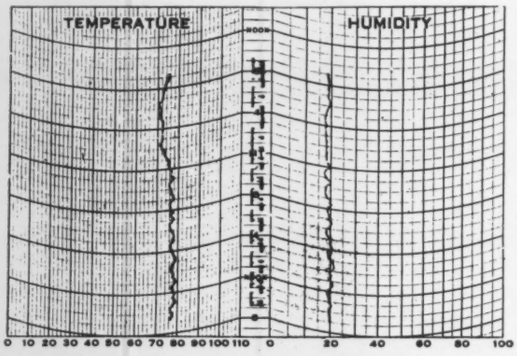

Fig. 6—House temperature record—stoker installation

Natural Gas

The results of the tests of the three heating plants which were fired with natural gas are presented in Table 3. Case 6 was a warm-air, furnace-burner unit, Case 33 was a boiler-burner unit, and Case 30 was a warm-air furnace with a conversion burner. All were equipped with room thermostats, and the boiler unit had a high-limit control actuated by the boiler pressure.

In the units of both Case 33 and Case 30 the air-gas ratio was well adjusted; the CO_2 content of the flue gases averaged 8.1 and 8.8 per cent, respectively, corresponding to 38 and 25 per cent excess air. In the unit of Case 6, however, although specifically designed for gas, a large opening around the burners had no controllable shutters, and so much air was admitted that the CO_2 was only 3.3 per cent. In all units the CO_2 remained practically constant during the entire test period when the burners were in operation.

As no unburned carbon monoxide was found in the flue gases and there was no ashpit loss, only three losses remain. The loss due to moisture was very nearly the same for the three installations. This is governed principally by the amount of hydrogen in the gas and amounted to 10 to 11 per cent, about twice that for coal-fired furnaces. The loss due to sensible heat in the dry flue gases was 8.3 to 15.6 per cent. The high loss for Case 6 was caused by the very high excess air, and that for Case 30 was caused by the high flue-gas temperature. The warm-air furnace, designed for coal, did not have the heating surface required to absorb the heat from the gases efficiently.

The *unaccounted-for* loss in firing by gas is due to errors and possibly to small amounts of undetermined combustible gases. In other tests[9] the average *unaccounted-for* loss, excluding radiation, for thirteen tests was 4.4 per cent. Therefore, a value of 5 per cent was assumed for these tests.

The deduction of the measured and assumed *unaccounted-for* losses from 100 left 69 to 76 per cent of the heat in the fuel as the overall thermal efficiency of these gas-fired units.

[9]Loc. cit. See note 3.

General Summary of Gas-fired Tests

Relation of Equipment to Operation. The one boiler-burner unit tested gave an efficiency approaching that generally assumed to obtain with gas-fired units; also the conversion burner in the warm-air furnace gave an efficiency as high as could be expected, although the flue-gas temperature was high. The warm-air furnace designed for gas gave surprisingly low results because of the very high excess air. These data show the value of careful adjustment of the air-fuel ratio and also show that it is inadvisable to assume that all gas-fired burners operate with the publicized performance of the best.

Oil-fired Tests

The results of tests of the heating plants which were fired with oil are presented in Table 4. Case 11 was a warm-air furnace which burned No. 3 oil with a pressure-atomizing burner, and Case 8 was a round cast-iron boiler which used No. 1 oil with a center-flame, rotary burner. Both installations were equipped with room thermostats and high-limit controls which gave good regulation of the house temperature.

The CO_2 content of the flue gases was similar in both installations, about 7 per cent, corresponding to about 100 per cent excess air. This is a lower CO_2 content than these burners should give under normal operation. The flue-gas temperature was not excessively high, 547 F, for the warm-air furnace but was much higher than it should have been, 866 F, for the steam boiler. The difference was partly, but not entirely, accounted for by the difference in weather during the week of the tests. Because of the low CO_2 the loss in heat in the dry flue gases was higher than is to be expected for oil-fired installations, and was particularly high, 30.3 per cent, for the steam boiler.

The loss due to moisture was about 8 per cent for both cases, higher than for coal, but somewhat less than for natural gas, as the hydrogen content of oil is intermediate between coal and gas.

In a series of tests[10] of oil-fired boilers an average value for 15 tests of 14.7 per cent for *Radiation and Unaccounted-for Loss* was reported. Assuming a radiation loss of 5 per cent, the average net loss due to unaccounted-for items would be approximately 10 per cent, which was the value assumed for the present tests.

Deducting the sum of the total losses from 100, the overall thermal efficiency of the two oil-fired heating plants was 51 and 65 per cent.

General Summary of Oil-fired Tests

Relation of Equipment to Performance. The overall efficiencies shown by these two oil-fired heating plants were lower than were to be expected of these fuels, but the reasons for the low efficiencies were fairly obvious. The air-fuel ratio was, as pointed out, much higher than should be maintained. If the burners were properly

[10]Comparison of Oil and Gas Firing in a Heating Boiler, L. E. Seeley and E. J. Tavanlar, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, October 1933.

Table 3—Performance Data
Gas Fired Plants

Item No.		"On" period	"Off" period	"On" period	"Off" period	"On" period	"Off" period
	General Information						
1	Case number	6		33		30	
2	Type of house	Wood		Wood		Brick	
3	Number of rooms	8		14		11	
4	Maximum Design heat loss of building—Btu per hr.	79,988		87,978		72,412	
5	Type of heating system	Warm Air		Steam		Warm Air	
6	Leader area—sq in.	646		...		772	
7	Radiation—sq ft	...		602		...	
8	Date of test	Dec. 9-13, 1935		Feb. 24-29, 1936		Mar. 2-6, 1936	
9	Duration of test—hrs	112		123		123	
10	Degree-days in test period	136		113		135	
11	Average daily mean temperature—F	36		43		38	
	Fuel						
12	Kind	Natural Gas		Natural Gas		Natural Gas	
13	Calorific value (gross)—Btu per cu ft	1000		1000		1000	
14	Total gas burned—metered—cu ft	4370		5795		4613	
15	Total gas burned—corrected to 30/60—cu ft	4375		5761		4594	
	Drafts						
16	Draft in furnace—in. water	0.006	0.008	....	....	0.011	0.019
17	Draft at flue gas outlet—in. water	0.055	0.036	0.010	0.003	0.017	0.020
	Flue Gases						
18	CO_2—per cent	3.3		8.1		8.8	
19	O_2—per cent	14.4		6.2		4.6	
20	CO—per cent	0.0		0.0		0.0	
21	N_2—per cent	82.3		85.7		86.6	
22	Dry flue gas per lb of fuel—lb	42.25		17.67		16.4	
23	Excess air—per cent	196.8		37.8		25.2	
	Temperatures						
24	Flue gases—F	346		427		687	
25	House living quarters, F	71		74		65	
26	House living quarters—relative humidity—per cent	44		38		46	
	Hourly Rates						
27	Fuel burned (average)cu ft per hr	38.95		47.15		37.5	
28	Heat Input (average)—Btu per hr	38,950		47,150		37,500	
	Burner Operation						
29	Average length "On" period—min.	12.0		25.2		66	
30	Average length "Off" period—min.		35.4		104.3		194
	Heat Balance Per						
31	Losses due to moisture	10.3		10.6		11.5	
32	Loss due to heat in dry flue gas	15.6		8.3		13.4	
33	Unaccounted losses (assumed)	5.0		5.0		5.0	
34	Total losses	30.9		23.9		29.9	
35	Overall efficiency (by difference)	69.1		76.1		70.1	
36	Total	100.0		100.0		100.0	

adjusted when they were installed, they had been allowed to get out of adjustment with consequent loss of efficiency. Before leaving each of these test houses, the burners were adjusted to give 10.0 and 9.5 per cent CO_2, which represented a gain in efficiency of 7 to 10 per cent for each unit.

The high flue-gas temperatures found in Case 8 were another example of the practice cited under the discussion of the performance of the stoker-fired tests. The burner and its rate of operation were not suited to the design of the boiler, and inefficient heat absorption resulted.

Although these results are not to be considered as representative of best practice, they are typical of the operation of many heating plants burning fuel oil. As a result of a survey[11] of oil-fired heating systems conducted in Madison, Wisconsin, it was stated:

"A survey of some 140 residence installations indicated a stack loss of 27 per cent as determined by a CO_2 average of 7.8 per cent and an average flue-gas temperature of 634 F. . . . A wide variation in stack losses was found indicating that many installations may be rated as excellent and others as unacceptably poor. The largest loss found in the survey was 46 per cent and the smallest was 10 to 11 per cent."

[11]Loc. cit. See note 2.

General Summary

For purpose of convenient reference in discussion of the general results of the investigation, Table 5 presents a summary of the most significant data and the heat balances of the 15 test installations.

Hand-fired Solid Fuel

The two principal sources of loss in firing bituminous or semi-bituminous coals by hand are the *unaccounted-for* losses, which include the losses in soot, tar, and gaseous hydrocarbons, and the dry-gas loss. The former loss is high because of the impossibility of burning the gases which are rapidly evolved when a heavy charge of fuel is fired at infrequent intervals, which is the common practice in domestic firing. The dry-gas loss is high because of the high excess of air generally carried; this, too, results from the infrequent attention to the fire.

The soot, tar, and hydrocarbon loss is so high that it offers a great field for improved devices or methods for firing boilers and furnaces by hand. The purpose of the coking, side-bank, alternate, and conical methods of firing is to reduce this loss.

The efficiencies found for coal fall within the lower limit of the range of efficiencies reported by the Bureau of Mines.[12] The average of the three values for bituminous coal is 47 per cent. It may be assumed that the efficiency of hand-fired residential installations using bituminous coal is an average value of 45 per cent. Some will undoubtedly obtain better results than this; a few may do worse.

The average of the two values for semi-bituminous coal is 53 per cent. It is higher than found for bituminous coal principally because of the justified assumption of the lower *unaccounted-for* loss. A probable average efficiency for this type of coal is 50 per cent.

With coke as a fuel, the loss in tar, soot, and hydrocarbons is practically eliminated because of the low content of volatile matter. Because of the absence of any caking action, more uniform fuel beds can be maintained and a lower excess of air is possible than when firing coal. The efficiencies actually found with coke in the two test installations were 75 per cent. It was recognized that the installations were better maintained and more carefully fired than the average. Hence an average efficiency for coke might be assumed to be about 70 per cent.

Although this assumption may seem high, it must be remembered that if coke is to give satisfaction and continue to be used, the heating equipment must be maintained in better condition, particularly as to control of drafts, and somewhat more intelligent, though not necessarily more frequent, attention must be given than can be done with coal. Hence a continued, satisfied user of coke is quite likely to be obtaining a relatively high efficiency.

[12] Loc. cit. See note 2.

Stoker-fired Coal

The losses due to soot, tar, and gaseous hydrocarbons are largely reduced when bituminous coal is burned on the small underfeed stoker. The stokers tested did not, however, maintain an excess of air as much lower than with hand-firing as would have been expected. This indicates the necessity of proper adjustment of the air-coal ratio. The principal cause of their high loss in sensible heat in the dry flue gas was the high flue gas temperature which resulted from the application of

Table 4—Performance Data
Oil Fired Plants

Item No.		"On" period	"Off" period	"On" period	"Off" period
	General Information				
1	Case number	11		8	
2	Type of house	Wood		Brick	
3	Number of rooms	7		9	
4	Maximum Design heat loss of building—Btu per hr.	65,937		78,366	
5	Type of heating system	Warm Air		Steam	
6	Leader area—sq in.	608		...	
7	Radiation—sq ft	...		392	
8	Date of test	Jan. 13-17, 1936		Feb. 3-7, 1936	
9	Duration of test—hrs	112		123	
10	Degree-days in test period	148		222	
11	Average daily mean temperature—F	33		23	
	Fuel				
12	Kind (A.P.I. Number)	No. 3 Oil		No. 1 Oil	
13	Calorific value (gross)—Btu per gal	141,600		133,534	
14	Calorific value (gross)—Btu per lb	19,300		19,752	
15	Total fuel fired—gas	46			89
	Drafts				
16	Draft in furnace—in. water	0.105	.085	.043	.044
17	Draft at smokehood—in. water	0.121	.088	.039	.038
	Flue Gases				
18	CO_2—per cent	7.4		6.7	
19	O_2—per cent	10.7		11.4	
20	CO—per cent	0.0		0.0	
21	N_2—per cent	81.9		81.9	
22	Dry flue gas per lb of fuel—lb	28.43		31.34	
23	Excess air—per cent	98		111.5	
	Temperatures				
24	Flue gases—F	547		866	
25	House living quarters, F	69		71	
26	House living quarters—relative humidity—per cent	43		29	
	Hourly Rates				
27	Fuel burned (average)—gal per hr	0.41		0.72	
28	Heat input (average)—Btu per hr	58,056		96,545	
	Burner Operation				
29	Average length "On" period—min.	22.2		31.2	
30	Average length "Off" period—min.		42.6		51.6
	Power				
31	Total Power—kwhr	6.0		3.4	
32	Power per 100 gal. oil fired—kwhr	13.0		3.8	
	Heat Balance—Per Cent				
33	Losses due to moisture	8.0		8.8	
34	Loss due to heat in dry flue gas	16.8		30.3	
35	Unaccounted losses (assumed)	10.0		10.0	
36	Total losses	34.8		49.1	
37	Overall efficiency (by difference)	65.2		50.9	
38	Total	100.0		100.0	

Table 5—Summary of Test Data

	Group 1 Bituminous Coal Hand-Fired			Group 2 Semi-Bitum. Coal Hand-Fired		Group 3 Coke Hand-Fired		Group 4 Bituminous Coal Stoker-Fired			Group 5 Gas-Fired			Group 6 Oil-Fired	
Case Numer	13	26	32	14	4	1	9	2	5	10	6	33	30	11	8
Type Heating System[a]	W.A.	St.	W.A.	W.A.	W.A.	W.A.	W.A.	St.	H.W	W.A.	W.A.	St.	W.A.	W.A	St.
CO_2 Per Cent	7.8	7.8	4.0	6.0	5.7	6.4	10.3	5.3	9.3	6.9	3.3	8.1	8.8	7.4	6.7
Excess Air in Flue Gases—Per Cent	105.0	108.5	310.0	182.0	188.5	182.0	86.7	206.5	76.8	135.8	196.8	37.8	25.2	98.0	111.5
Temperature of Flue Gases—F	454	574	363	428	463	219	475	358	882	749	346	427	687	547	866
Heat Balance—Per Cent															
Losses Due to Moisture	4.7	4.6	5.9	4.0	4.0	0.7	0.7	4.9	5.4	5.0	10.3	10.6	11.5	8.0	8.8
Losses Due to Heat in Dry Flue Gases	16.8	27.8	27.6	21.5	24.4	9.6	17.0	21.1	32.3	34.7	15.6	8.3	13.4	16.8	30.3
Losses Due to Carbon Monoxide	4.0	1.4	1.3	0.9	1.0	3.2	2.0	0.0	1.2	0.0	...	...	...	...	...
Losses Due to Unconsumed Carbon in Ash	1.0	0.4	3.8	4.6	3.3	0.6	0.5	0.0	0.0	0.3	...	...	...	...	...
Unaccounted Losses (assumed)	20.0	20.0	20.0	15.0	15.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	10.0	10.0
Total Losses	46.5	54.2	58.6	46.0	47.7	84.1	25.2	31.0	43.9	45.0	30.9	23.9	29.9	34.8	49.1
Overall Efficiency (by difference)	53.5	45.8	41.4	54.0	52.3	75.9	74.8	69.0	56.1	55.0	69.1	76.1	70.1	65.2	50.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a]W.A.=Warm Air.
St.=Steam.
H.W.=Hot Water.

stokers with high rates of heat liberation to boilers and furnaces designed for much lower rates. The stoker must be properly sized to the boiler or furnace, and equipment particularly designed for stoker operation is very much to be desired for new residential installations.

Excluding the one value of 69 per cent, which was principally due to a very large boiler, the average efficiency was 55 per cent, which may be assumed to be representative of this type of installation.

Natural Gas

When gas was used as a fuel, the losses to *unaccounted* items and the sensible heat in the dry flue gas were both low. The loss due to moisture in the flue gas was about twice that of coal because of the high hydrogen content of the gas; this is inherent to the fuel.

The efficiency found for the gas-designed warm air furnace and for the warm-air furnace with a conversion burner was 70 per cent. For the designed boiler-burner unit, the efficiency was 75 per cent. Both of these values are in the range to be expected.

Oil

The principal source of loss of heat when firing oil was in the sensible heat in the dry flue gas. This was higher than it should have been, because the excess air was high due to improper adjustment of the air-oil ratio and, as with stokers, to the liberation of heat at rates higher than those for which the furnace or boiler was designed. The average efficiency found was 58 per cent; a value of 60 per cent may be assumed as typical.

Effect of Equipment

The normal expectations would have been that definite trends in efficiency of warm-air furnaces, hot-water and steam boilers would have been found but, as pointed out, this was true only with gas as a fuel. The many other variables, as condition of the equipment, correctness of adjustment, and the degree of attention to the fire, obscured for the relatively few installations tested the effect of the type of heat transfer unit.

For residential heating equipment in general, therefore, the following values may be assumed as the thermal efficiencies reasonably to be expected:

	Per Cent
Bituminous coal, hand-fired	45
Semi-bituminous coal, hand-fired	50
Coke, hand-fired	70
Bituminous coal, stoker-fired	55
Natural gas, conversion burners	70
Natural gas, designed burner-boilers	75
Oil, conversion burners	60

Heating Satisfaction

Some of the comments of the users of the various fuels are of interest. Although the 1935-36 heating season was one of the most severe in years, all the users expressed satisfaction with the fuel they were using insofar as its ability to maintain the home comfortably heated was concerned. Neither did any of the users, even those with hand-fired installations, complain of lack of convenience of the fuel. All of those who fired bituminous coal by hand did complain of the lack of cleanliness, but only two of the six users of stokers mentioned lack of cleanliness of coal. Neither of these two was using oil-treated coal, which would have removed the cause for complaint, as others mentioned their satisfaction with the dustless feature of coal that had been treated with oil.

Thermostatic control of the rate of burning was found to be of considerable value, even on hand-fired coal furnaces, in the maintenance of uniform temperatures, especially where equipped with a limit control. The stokers were found to give excellent control of the room temperature.

Cost of Heating

To the heating and ventilating engineer, this discussion of the sources of loss of heat and the resultant efficiencies in the combustion of various fuels for home heating is of interest from the standpoint of combustion and heat transfer. To the occupant of a home, however, the thermal efficiency is of interest only as it affects the amount of his heating bill. In addition to the data presented in this paper, data were obtained during the investigation on the costs of heating in the 15 test houses and 15 other houses. These data were not considered to be appropriate to the present paper, but are presented in a complete report[13] published by Bituminous Coal Research, Inc.

As, in most parts of the United States, the cost of heat in coal or coke is considerably cheaper than in gas

[13]Technical Report No. 3, December, 1936, Efficiencies and Costs of Various Fuels in Domestic Heating, by Ralph A. Sherman and R. C. Cross, Bituminous Coal Research, Inc., Washington, D. C.

or oil, it is evident that, despite the lower efficiencies, the cost of the heat delivered to the house will generally be lower with solid fuel than with liquid or gaseous fuels. Also it is evident that because of the higher efficiencies to be obtained with the use of coal on stokers the cost of heat on the basis of fuel costs will be less than with hand firing. If the cost of the coal for stokers is lower than for hand-firing, as it frequently is because of the smaller size of coal used, additional savings are made. As the stoker requires power for its operation, the cost of current must be deducted, but the net saving in fuel cost is appreciable.

Properly speaking, although it is seldom considered by the homeowner, the cost of heating must include the depreciation, interest, and maintenance cost on the entire heating plant. These costs are obviously lowest for hand-fired installations. Whether or not the savings due to increased efficiencies will offset the fixed charges on the automatic firing equipment will depend on the amount of fuel used which is governed by the size of the installation and the severity of the climate. For the average home in most parts of the country, coal stokers are the only form of automatic heating with which there is any saving in fuel cost as compared to hand-firing to offset the increase in fixed charges on the heating equipment. With other fuels there are not only additional fixed charges but also additional cost for fuel.

The really important advantages of automatic heating of homes are increased comfort, increased convenience, and increased cleanliness. What any given person will pay to attain some measure of these advantages will depend on his economic status and his habits of thought. It is the duty of the heating engineer to set up for the homeowner a balance sheet for his local conditions which will show truly the overall costs of the available methods of heating. To do this, the probable attainable thermal efficiencies are necessary. It is the hope of the authors that the data presented in this paper will be helpful to that end.

Acknowledgments

The test observations were made by Elmer White and Henry N. Ostborg of the Fuel Division of Battelle Memorial Institute. Analyses of coal and ash samples were made in the chemical laboratory of the Institute under direction of J. D. Sullivan.

Acknowledgment is made of the cooperation of the local homeowners which made it possible to carry on the investigation. The assistance of Arthur Lloyd, Columbus Division, City Ice and Fuel Co., of Campbell J. Graf, Williams Oil-O-Matic Sales and Service, H. E. Irion, National Refining Co., and M. S. Roberts, Roberts Plumbing Co., in locating suitable homes burning the several fuels is also gratefully acknowledged.

The cooperation of W. T. Alexander, chief of Columbus Station, U. S. Weather Bureau, in furnishing special compilations of weather data is greatly appreciated.

Testing Exhaust Systems

At a recent meeting of the National Safety Congress and Exposition held in Atlantic City, F. C. Houghten* and David Shore† outlined the fundamental requirements in the design of an exhaust system as follows: (1) that a sufficient velocity of approach to the inlet of the system be maintained to move the contaminating substances in the system; (2) that a sufficient velocity through the duct system be maintained so that this material is not deposited on the way; and (3) that means be provided for collecting these materials or otherwise disposing of them at the exit of the system. It was indicated while these fundamentals are simple the practical evaluation of the requirements for any specific case may be exceedingly complicated.

In considering the question of design methods for exhaust systems three rather distinct objectives may be recognized which naturally dictate somewhat different test procedures.

1. An acceptance test, either to demonstrate that the system has been installed in accordance with specifications, or if it has been so installed, to demonstrate that it will adequately take care of the purpose for which it was designed.

2. A test, made by the operating engineer, to insure that the system continues to operate as originally designed and installed, or to insure that with changing plant and duct conditions, it continues to be adequate to insure a satisfactory air condition.

3. A test designed to insure that the particular industry is properly guarding the health of its employees. Such tests may either be required by the representatives of the employees themselves, or by some official industrial or labor commission.

Acceptance Test

Generally, in the acceptance test little more is required than an inspection of the size of the equipment including size and shape of the hoods, the size of the ducts, fan capacity and fan speed. If the acceptance test is to insure not only that the installation is made in accordance with specifications, but also that the operation of the system gives the required or predetermined standards of dust removal at the source, or if it is to insure the maintenance of certain standards of air purity within the plant, then the test method must include additional features. Probably the most valuable observation for such a test is the resulting degree of air pollution in the plant. Air should be sampled for determination of pollution at representative locations and the degree of pollution determined by one of the well accepted methods. If the prevalence of dust is particularly fine and toxic or if toxic gases or vapor are dealt with, a sampling method permitting chemical analysis may be required.

Operating Test

Testing by an operating engineer in order to insure satisfactory operations should occur at regular and periodical intervals. Such a test schedule should be designed not only to insure satisfactory working conditions under varying plant operation even when the system is known to have been properly installed but also to avoid unsatisfactory performance of the system due to the development of defects.

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The Noise Characteristics of Air Supply Outlets

By D. J. Stewart* (*MEMBER*) and G. F. Drake** (*NON-MEMBER*), Rockford, Ill.

NOISE is one of the first considerations which arises when one attempts to specify a suitable grille for an air supply outlet in a ventilating system. This paper summarizes the results of studies of the noise level of grilles of various types and sizes and with different air velocities. The data are presented in a form that can be used conveniently in a straightforward method of grille selection which is also described.

Influence of Noise on Grille Selection

After the heating or cooling load calculations have been completed, a supply air temperature has been selected, and the volume of air required determined, the next step is to determine the velocity at which air may be introduced into the space without objectionable noise or objectionable drafts. In this discussion, the noise from the fan and duct system itself will be neglected and only the noise produced by the grille considered.

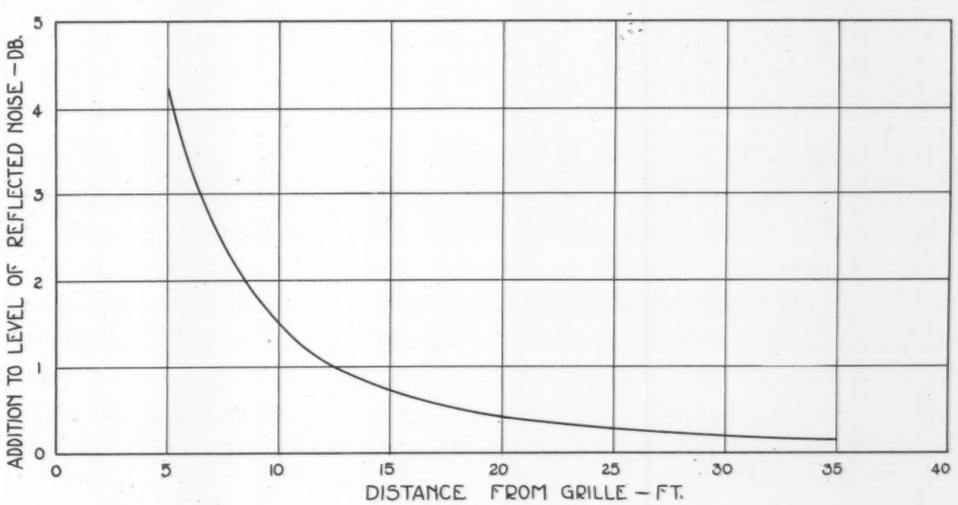

Fig. 1 — Decibel addition to loudness level of reflected sound. Room absorption 270 Sabins. Long throw grille

If the fan and duct system is properly constructed and acoustically treated, the noise from this source can be neglected except at extremely low grille velocities. The noise level of the open duct in the tests under consideration was below 23 decibels (db) at an outlet velocity of 1000 fpm. Since high velocities mean smaller ducts and outlets, it is advantageous economically to use the maximum velocity permitted by the desired noise level or by the distribution characteristics. The selection of the proper velocity requires that the designer have available reliable data on the noise characteristics, applicable to the particular make of outlet it is proposed to use. Before a final selection can be made, the designer must also have data on the distribution characteristics, but that phase of the subject will not be discussed in this paper.

Meter Location

It is assumed that the reader is familiar with the elementary principles of the theory of sound as well as of the decibel scale. All intensity figures given in this paper are on the decibel scale and refer to the now generally accepted threshold, 10^{-16} watts (w) per square centimeter.

When air is introduced into a room through a grille, sound energy is produced at the grille; and if the air is at a constant velocity, the sound energy is, for all practical purposes, produced at a constant rate. If there were no reflections, the intensity of the sound would be approximately proportional to the rate at which the energy is generated and inversely to the square of the distance between the grille and the observer. This is not the case in an ordinary room, for due to partial reflection at the boundaries the intensity of sound at any point in the space builds up immediately to a constant value higher than that which would be indicated by the rule given. In a large room at a point remote from the source of sound, the intensity can be shown to be substantially proportional to the rate at which sound is generated and inversely proportional to the number of sound absorption units in the room and independent of the distance from the outlet. It is not satisfactory to consider the grille noise on this latter basis, since the occupants of the room may be very close to the grille.

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For presentation at the 43rd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, St. Louis, Mo., January, 1937.

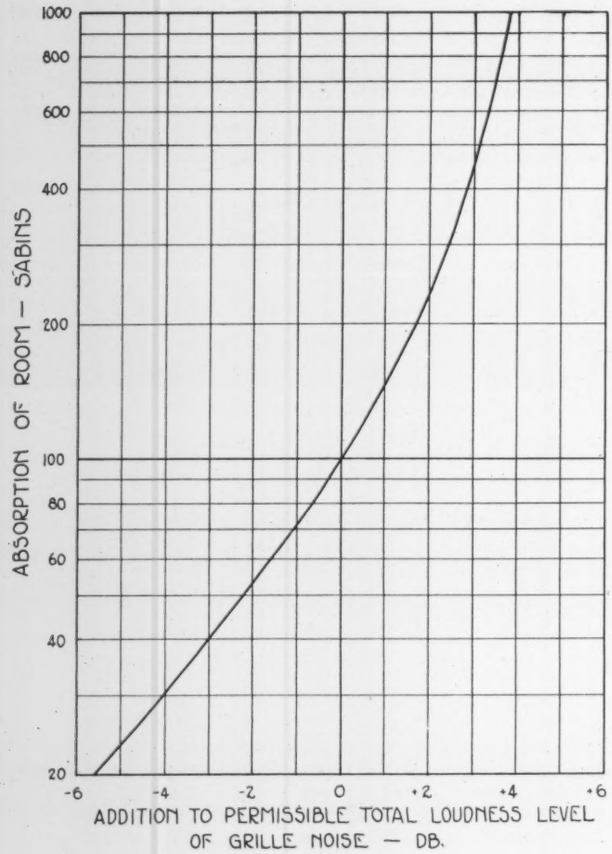


Fig. 2—Decibel correction for room absorption. Referred to room of 100 Sabins

The authors know of no generally accepted standards as to the place at which sound measurements should be made, but it appears unlikely that an occupant will be nearer than directly in front of the grille, 5 ft from the lower edge of the outlet, this distance measured downward at an angle of 45 deg. All measurements referred to in this paper were made at this position. Fig. 1 indicates the manner in which loudness level varies with position.

Room Absorption

The effect of the absorption characteristics of the room on the intensity at this point is not nearly so great as at remote points in the room, but nevertheless cannot be ignored completely.

It can be shown that the ratio between direct and reflected sound intensity in a room is expressible as

$$R = \frac{SC}{16\ \pi\ d^2} \times \frac{\alpha}{1-\alpha} \qquad [1]$$

where

S = surface area of the room,
d = distance from the source,
α = average absorption coefficient.
C = directivity of the sound source.

For a given type of grille the value of C can be determined from this equation as follows: the distance d is that from the source to the standard listening position (5 ft). S can be calculated from test room dimensions, and α determined from published data on the absorption coefficients of various construction materials. If now the intensities at distance d and at some point remote from the source (so that direct sound is negligible) are measured, the ratio R may be computed as

$$R = \frac{I_T - I_R}{I_R} \qquad [2]$$

where

I_T = Total intensity as measured at d,
I_R = reflected intensity as measured at the remote point, the difference being the direct intensity at d.

All the unknowns of equation (1) except C are now established, and C can therefore be computed. By this semi-empirical means it is possible to establish a relation which, by justifiable approximations, can be simplified to

$$\triangle L = 10 \log\left(1 + \frac{K}{a}\right) \qquad [3]$$

where

$\triangle L$ = loudness addition in decibels,
K = constant including the factor C,
a = absorption of the room in *sabins*.

From this expression it may be seen that when the absorption is infinite (as in free space) the addition $\triangle L$ is zero, as would be expected. From this equation a curve could be plotted showing the additions in decibels which should be made to the *free space loudness* of a particular type grille when placed in a room of absorption a. In order that such a curve might be more directly applicable, a base of 100 sabins was chosen and the corrections referred to a room having this absorption. Although the curve shown in Fig. 2 is for only one type of grille, it may be used for any type of grille with sufficient accuracy for all practical purposes. The sound absorption of the test room is approximately 270 sabins, but all the data shown herein are corrected to an absorption of 100 sabins. An average room will have an absorption of more than 100 sabins, and failure to correct for this factor will, therefore, give a permissible sound level lower than that which could actually be used. The error in this case is on the side of safety. It is only where the room is highly reflecting or very small that there is any great necessity of taking this factor into account. The total absorption coefficient can be computed from the usual acoustical formula. A table of the coefficients of most of the usual interior finishes is given on page 331 of THE A.S.H.V.E. GUIDE, 1936.

Loudness vs. Velocity

In Fig. 3 are shown as circles a number of test values of loudness level for a long throw type grille of one square foot area (corrected to a room of 100 sabins absorption) with various face velocities. A curve such as the full line of Fig. 3 might be considered a fair representation of these data. Consideration of this curve and the physics of the problem suggested that the sound intensity might be proportional to some power of the face velocity. This led to the derivation of the following equation:

$$L_s = b \log V + c \qquad [4]$$

where

L_s = loudness for 1 sq ft core area (specific loudness)
V = face velocity (feet per minute)
b and c = constants dependent upon grille.

The determination of constants b and c by substitution

of two sets of test data in the above equation gave the following results for the long throw type grille:

$$c = -91.1$$
$$b = 44.0$$

Substitution of these values in (4) gives

$$L_s = 44 \log V - 91.1 \quad [5]$$

The full and dotted line of Fig. 3 is the graphical representation of (5). This curve may be seen to check almost exactly at all measured values of L_s, passing, of course, through the two points used in determining b and c. Below these points (dotted line) no satisfactory check has yet been made, because of the low general noise level required, but the shape of the curve seems reasonable. It should be noted that the curve reaches zero loudness level at about 118 fpm face velocity. This does not mean that no sound energy is produced at this velocity, but that it is at the threshold of audibility in a room of absolute silence. If the room noise level is itself at the threshold, the combination would produce a noise of 3 db since it would be twice threshold intensity. Further examination of this curve and consideration of its equation shows that it approaches the zero velocity line asymptotically, reaching it at minus infinity loudness level; this means only that the sound energy, the logarithm of which (in threshold units) is the loudness level, reaches zero at zero velocity, as might be expected. It is intended to check this curve experimentally at somewhat lower velocities when a better location and better apparatus are available, but it is believed safe for practical purposes.

Correction for Grille Area

Correction must be made for area to obtain the total sound level. This can be done by the use of the formula:

$$D = (\text{decibel addition for area}) = 10 \log_{10} A \quad [6]$$

where

A = core area in square feet.

Since the allowable total sound and the required volume of air are usually known, and it is desired to determine the maximum allowable velocity, the chart and formula given involve a trial and error method, for the volume cannot be determined until an assumed velocity has been decided upon; and then the grille size, unless it happens to be one square foot core area, will indicate a different sound level than that originally chosen. To avoid this, a family of curves shown in Fig. 4 may be used. These curves are simply the relation between volume of air and face velocity at constant loudness. If the volume and desired total noise are known, the maximum permissible velocity can be directly determined. Fig. 4 is based on the same grille construction as Fig. 3. It is interesting to note that the curves in Fig. 4 are straight lines. The reason for this is given in the following discussion.

It has been shown that the loudness per square foot and the addition for area may be represented respectively by

$$L_s = b \log V + c \quad [4]$$
$$D = 10 \log A \quad [6]$$

The value of A may be expressed in terms of velocity and rate of flow as

$$A = \frac{Q}{V} \quad [7]$$

where

Q = rate of flow in cubic feet per minute.

The total loudness level of a grille is

$$L_T = L_s + D \quad [8]$$
$$= b \log V + c + 10 \log \frac{Q}{V} \quad [9]$$

Solving this for log Q,

$$\log Q = \frac{L_T}{10} - \frac{(b-10)}{10} \log V - c \quad [10]$$

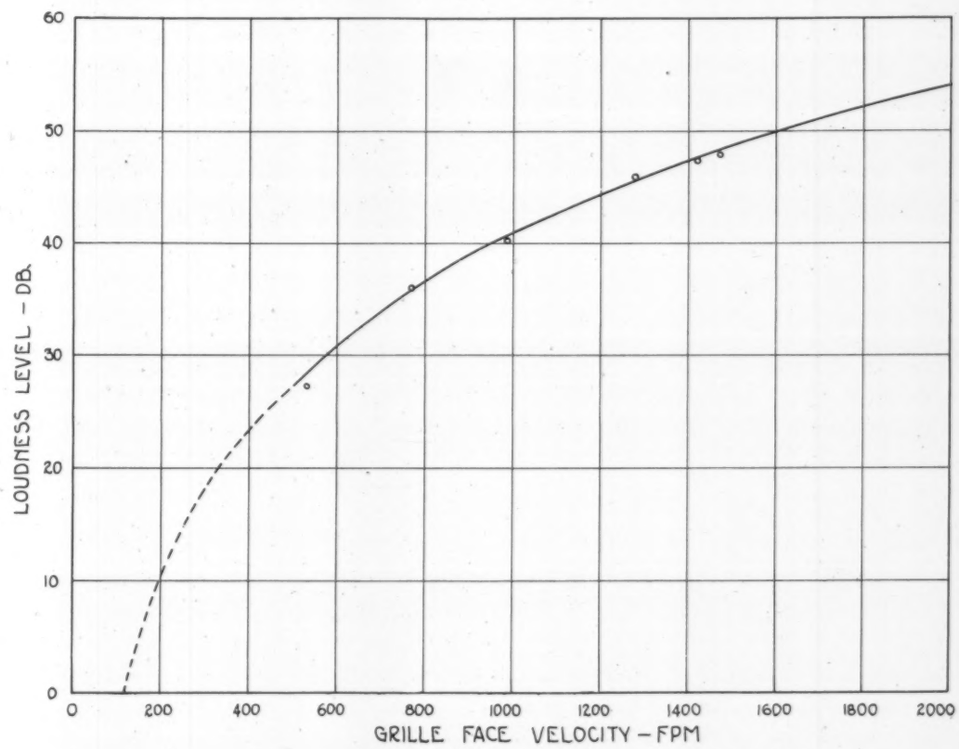


Fig. 3—Specific loudness of long throw grille. Room absorption 100 Sabins

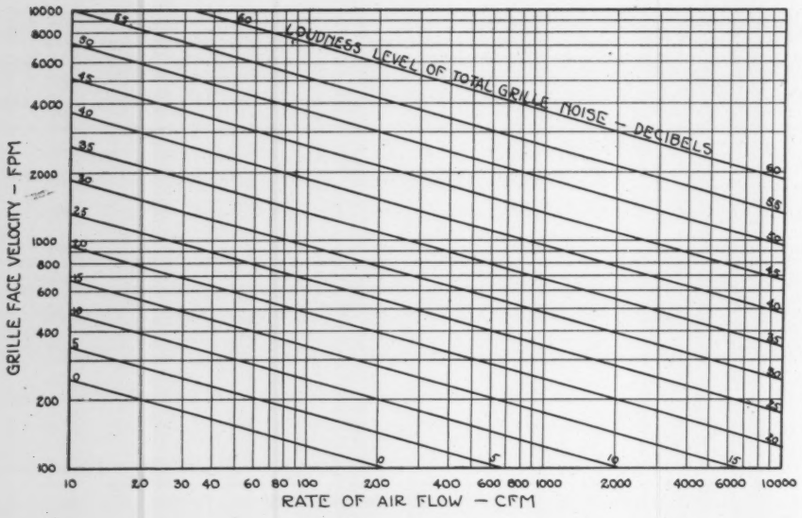


Fig. 4—Family of constant loudness lines for long throw grille. Room absorption 100 Sabins

The constants b and c are the same. Since both Q and V appear as logarithms, the relation between them will appear as a straight line on logarithmic paper. Various values for L_T determine, therefore, a family of straight lines on logarithmic paper.

Permissible Sound Level

In order to determine the permissible sound level, it is necessary either to know or assume the noise level of the room without the grille noise. In many rooms the noise level will vary, and it is usually necessary to design the system for satisfactory performance with the minimum noise level which it will have when occupied. If the noise level without the air conditioning system is known and the permissible noise level with the system in operation is known, the permissible maximum noise level due to the grille itself may be computed. The alignment chart, Fig. 5, solves this problem directly and eliminates the necessity of any computation.

Experience indicates that an increase in noise level of 1 db (at about 30 db) can hardly be detected, but that 2 db increase can be detected. If the fan is started and stopped during occupancy, an increase of more than 1 db is usually objectionable; and by referring to the chart it is found that this requires that the noise level of the grille be about 5 db below the noise level of the room without the grille. On the other hand, if the fan runs continuously, an addition of 3 db or even more is often entirely unobjectionable. An increase of 3 db in total noise permits the grille noise alone to be equal to the room noise without the grille.

When more than one outlet must be considered, the problem of whether to consider the total air volume or that from one outlet is dependent upon the location of the outlets and the sound absorption characteristics of the room. If two outlets are located some distance apart in a highly absorbent room, the noise level can be computed on the basis of a single outlet. On the other hand, if the room is small, and especially if it is highly reverberant, the noise level should be computed on the basis of the total volume of all the outlets. As the latter assumption errs in the direction of safety, it is the usual practice.

Example

Assume that the load calculations have been made and the supply air temperature selected, and that as a result the volume of supply air has been determined to be 900 cfm.

The room in which this system is to be installed is quite reverberant and has an absorption of only 50 sabins. The room noise level without the air conditioning system has been determined to be 45 db, and the air conditioning system itself has been quieted so that the noise from it can be neglected. On account of the small volume of air, it is probable that only one supply outlet will be used in this instance, but even if more than one supply outlet is contemplated it will be wise to consider the total volume of air as concentrated at one point since the absorption coefficient is so low. The system will not run continuously, and it is required that the additional noise of the grille will not be noticeable. As previously stated, an increase in the total noise level of approximately 1 db is not noticeable, and reference to Fig. 5 indicates that the grille noise level must be about 5 db below the room level or 40 db. However, the absorption coefficient of this room is only 50 sabins, and

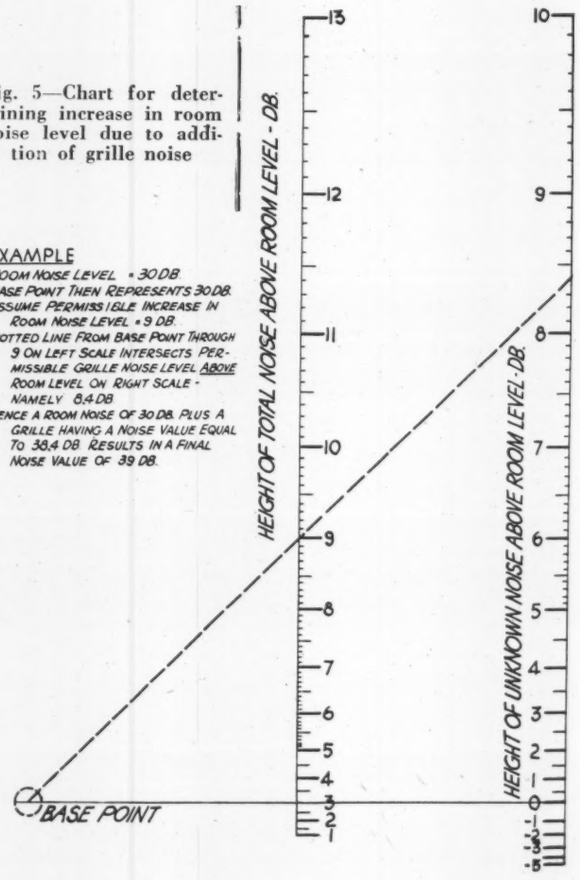

EXAMPLE
ROOM NOISE LEVEL = 30 DB.
BASE POINT THEN REPRESENTS 30 DB.
ASSUME PERMISSIBLE INCREASE IN ROOM NOISE LEVEL = 9 DB.
DOTTED LINE FROM BASE POINT THROUGH 9 ON LEFT SCALE INTERSECTS PERMISSIBLE GRILLE NOISE LEVEL ABOVE ROOM LEVEL ON RIGHT SCALE - NAMELY 8.4 DB
HENCE A ROOM NOISE OF 30 DB. PLUS A GRILLE HAVING A NOISE VALUE EQUAL TO 38.4 DB. RESULTS IN A FINAL NOISE VALUE OF 39 DB.
HEIGHT OF TOTAL NOISE ABOVE ROOM LEVEL - DB.
HEIGHT OF UNKNOWN NOISE ABOVE ROOM LEVEL - DB.
BASE POINT

Fig. 5—Chart for determining increase in room noise level due to addition of grille noise

reference to Fig. 2 indicates that the permissible level of grille noise must be reduced 2 db on this account. The net permissible grille noise is thus 38 db, and by referring to Fig. 5 it will be seen that this corresponds to an air velocity of 880 fpm. It is possible that consideration of the flow and distribution characteristics may require a lower velocity, but no higher velocity may be used and still fulfill the requirements as to noise.

The Test Procedure

The Test Room

The room in which the sound data described herein were taken is one which is regularly used for air distribution tests. The building itself is of poured concrete, pillar and slab construction, with a flat concrete ceiling covered with built-up composition roofing. The test room is on the sixth floor of this building, and is 37 ft long, 17 ft wide, and 9 ft 7 in. high. The long side walls are of sheet metal, outside of which are narrow spaces adapted to be heated to maintain room temperature during tests with cool air. The ceiling is ¼ in. rigid insulation on joists about a foot below the concrete slab of the roof. The floor is concrete. The grilles are located for test in the center of one end wall and about 7 ft 6 in. from the floor. An exhaust grille, extra large to reduce velocity and therefore noise to a negligible value, is located in the center of the same wall at the floor. This wall is also of ¼ in. rigid insulation and forms the front of a pressure box 5 ft deep and 8 ft wide extending from the top of the exhaust grille to the ceiling. Air is introduced into this box near the bottom and at velocities greatly reduced by a diverging nozzle with splitters. The duct supplying this nozzle is acoustically treated to eliminate noise from the fan system. The exhaust or return duct is similarly treated. Behind the test grille is mounted a 3-ft section of duct to simulate an actual installation. Careful tests have indicated that the flow of air from the pressure box through this duct is uniform over its entire cross-section.

Although the metal walls and concrete floor are highly reflecting, the unpitched character of the noise (see Fig. 7) offered no difficulties due to standing waves, and the ceiling and end wall material brought the absorption of the room as a whole to approximately 270 sabins (by computation).

The Fan System

The source of air was the fan of an air conditioning system used for flow and distribution tests on grilles. This is a standard direct expansion refrigerant installation of 10 ton capacity with provision for reheating and humidifying. Two multi-speed direct current motors are available to give fan speeds of 25 to 700 rpm. In the supply duct is a carefully calibrated venturi nozzle having an 18 in. approach duct and 10 in. diameter throat. Pressure lines are carried from this nozzle to a small room off the test room where the pressures are measured accurately with a Wahlen gage capable of detecting a pressure difference of one half thousandth of an inch of water. By these means the volume of air being supplied to the pressure box is measured rapidly and with considerable accuracy. A slope gage is provided for measuring the static pressure in the box and a curve of pressure versus cubic feet per minute leakage with grille opening closed provides means of making correction for this source of error which is, however, quite small. A remotely operable butterfly damper in the supply was used to secure final adjustment of air flow.

The Sound Level Meter

All sound measurements were made with a standard type sound meter graduated in decibels, but not above the now accepted standard of 10^{-16} w per square centimeter. In addition, a separate amplifier having a gain of about 25 db was used on the low velocity measurements. All data taken were corrected to the *A.S.A.* standard of 10^{-16} w per square centimeter by the addition of 7 db to the meter readings.

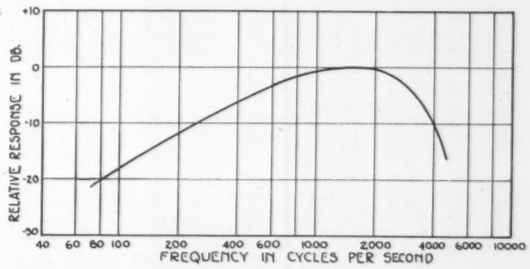


Fig. 6—Approximate overall frequency weighting characteristic of noise meter

The frequency response characteristic of the sound level meter is approximately as shown in Fig. 6. This deviation from uniform response is accomplished by a frequency weighting network and is intended to approximate the response of the human ear at a loudness level of about 50 db. That this is not correct for other energy levels is clear by inspection of the equal loudness contours which are a part of the *American Tentative Standards for Noise Measurement* Z24.2, 1936. However, because the frequency of the most prominent grille noise components appears to lie between 500 and 2000 cycles (see Fig. 7), the error introduced at loudness levels other than 50 db is less important than it might otherwise be. It is proposed that these data be checked with a sound level meter, when available, which meets the *American Tentative Standards for Sound Level Meters* Z24.3, 1936.

The Test Data

As stated before, the standard listening position was chosen at a distance of 5 ft from the lower edge of the grille downward at 45 deg in a plane perpendicular to the grille face at its center. A stand was provided for holding the noise meter with its microphone facing the grille at this position. With the fan running, the butterfly damper was closed to stop air flow, and the room noise level measured with the noise meter in standard position. The air flow was then adjusted to approximately the desired value, the actual flow through the venturi nozzle measured, the static pressure in the box noted and, from the leakage curve, correction made to

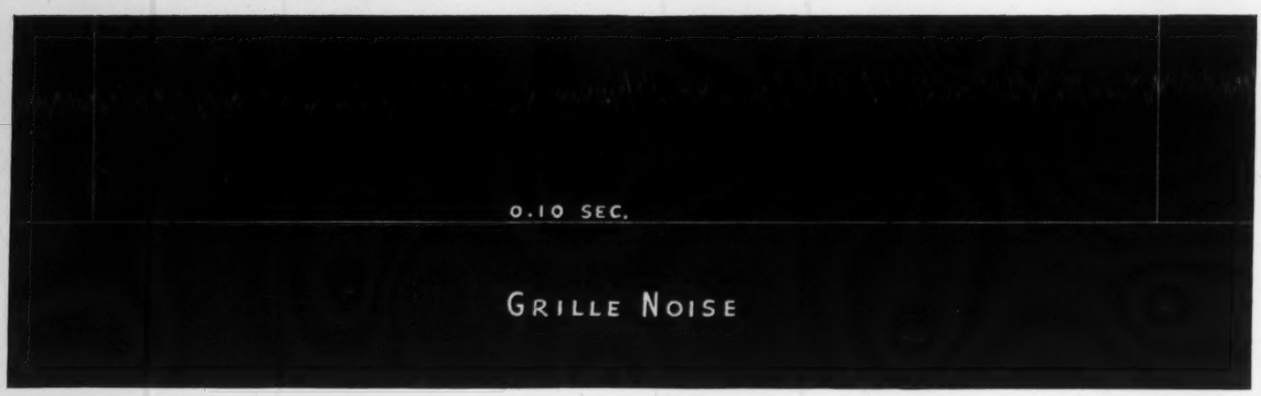


Fig. 7—Oscillogram showing frequency characteristics of grille noise

give net flow through the grille. The net core area having been carefully measured, a simple division gives the average face velocity. A noise level reading with this air flow determines one point on the curve of noise level versus velocity for this particular grille type and area.

The corrections previously described permit conversion to loudness of the grille noise only per square foot of core area in a room of 100 sabins absorption.

A number of readings were taken at other than the standard listening position in order to determine the relation of sound level at these positions to that of the standard position. The curve of Fig. 1 represents quite closely the locus of these test data. The level of the purely reflected sound is substantially that at the most remote point of the room. The curve of Fig. 1 was determined mathematically in the following manner.

After c has been established, equation (1) may be reduced to

$$R = \frac{K}{d^2} \qquad [11]$$

and from equations (11) and (2)

$$I_T - I_R = \frac{K}{d^2} I_R \qquad [12]$$

or

$$I_T = \left(\frac{K}{d^2} + 1 \right) I_R \qquad [13]$$

The difference in decibels between the level of purely reflected sound and the total sound may be expressed as the logarithm of their intensity ratio.

$$L_T - L_R = 10 \log \frac{I_T}{I_R} \qquad [14]$$

From equations (13) and (14)

$$L_T - L_R = 10 \log \left(\frac{K}{d^2} + 1 \right) \qquad [15]$$

Sources of Error

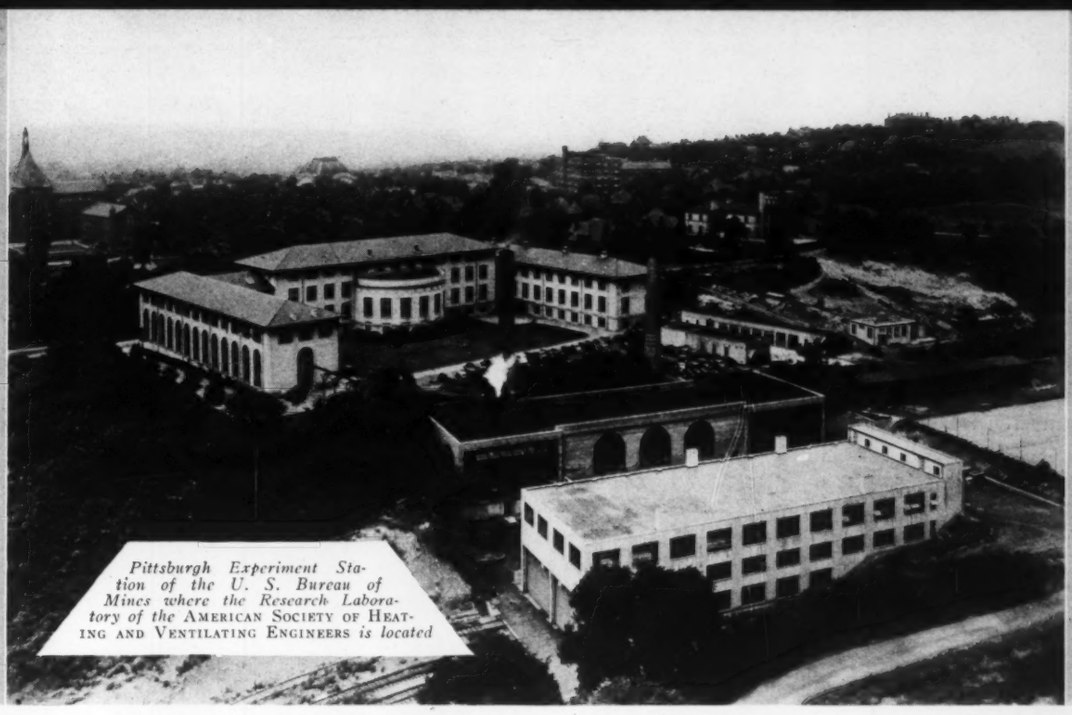
There are several obvious sources of error. First, the measurement of air flow depends upon the accuracy of calibration of the venturi; at the rates of flow used, this calibration is probably accurate to ±1 per cent. The error in reading is approximately of the same order, for although the sensitivity of the Wahlen gage is much better than this, the fluctuations in pressure add appreciably to the error in reading. Although the determination of leakage at a given pressure may be in error by ±10 per cent, this leakage is such a small part of the total flow that the error in net flow due to this is probably less than ±1 per cent. Errors in measurement of core area are neglible relative to the above. Thus, it would appear that the maximum error in average face velocity as recorded is ±3 per cent. Because of the way in which the loudness level varies with velocity (see equation (5)), this is equivalent to less than ±0.6 db.

Means to check the absolute values of the sound meter readings were not available. However, the instrument was calibrated by the manufacturer, and it was possible to check from time to time the gain of the amplifying system. It is not likely that the dynamic system of the microphone suffered any considerable change during the testing period, so that even if the absolute value is in error the relative values are probably quite accurate. The meter itself has a sufficiently open scale so that it is easily read to 0.5 db, although at the very low levels the fluctuation of extraneous noise increases this error to about 1 db. The gain of the external amplifier was checked frequently by taking the meter readings with and without the amplifier for a constant sound high enough in intensity to be readable without the amplifier.

It appears probable that, assuming no error in absolute value of loudness level, the total of all remaining errors did not exceed ±1 db for a single observation, except perhaps at the very lowest velocities. Inasmuch as several observations were made for each point, the probable error is believed to be approximately ±0.5 db, again excepting the error in absolute loudness level.

Statistics on Air Conditioning Orders

Statistics for the month of October on the value of orders booked for air conditioning systems and equipment have been released by the Bureau of Census, Department of Commerce, Washington, D. C. A survey of the figures included in this report indicates that from 98 manufacturers in this particular field during the first 10 months of this year, from January to October, a total of $35,680,483 have been booked and recorded from information supplied by the various individual manufacturers. The total value of orders booked by these same manufacturers during October, 1936 amounted to $4,172,028 as compared with $3,351,999 for September, 1936.



Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

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NOMINATIONS FOR 1937

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1937, submits the following list of nominees:

For President:

D. S. BOYDEN, Boston, Mass.

For First Vice-President:

E. H. GURNEY, Toronto, Ont., Can.

For Second Vice-President:

J. F. MCINTIRE, Detroit, Mich.

For Treasurer:

A. J. OFFNER, New York, N. Y.

For Members of the Council:

Three-Year Term

J. J. AEBERLY, Chicago, Ill.
M. C. BEMAN, Buffalo, N. Y.
E. O. EASTWOOD, Seattle, Wash.
W. A. RUSSELL, Kansas City, Mo.

Respectfully submitted,

NOMINATING COMMITEE,

J. H. VAN ALSBURG, *Acting Chairman;*
R. J. TENKONOHY, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1937:

Three-Year Term

H. E. ADAMS, South Norwalk, Conn.
A. E. STACEY, New York, N. Y.
G. L. TUVE, Cleveland, Ohio.
J. H. VAN ALSBURG, Chicago, Ill.
J. H. WALKER, Detroit, Mich.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Statue of St. Louis

St. Louis Is Ready

THE Committee on Arrangements of St. Louis Chapter is waiting to welcome members of the Society who will attend the 43rd Annual Meeting to be held in the Hotel Statler, January 25-27.

C. R. Davis, General Chairman, and members of his Committee hope that one of the New Year's Resolutions made by Society members, is to attend the Annual Meeting and enjoy the technical and entertainment programs that have been planned.

Every Chapter will send an official delegate and a meeting of this group is scheduled for 10:00 a. m. on Monday, January 25. Speakers will be Pres. G. L. Larson, W. A. Russell, W. H. Driscoll and D. S. Boyden.

During the entire morning on Monday committee meetings will be held and registration will be completed. A "Get Together" luncheon will be held at 12:30 p. m. in Hotel Statler so that everyone will have an opportunity to get acquainted and renew old friendships.

Four technical sessions will be held and a number of committee reports will be presented in addition to papers on concrete conductivities, fan characteristics, duct design, noise, health aspects of air conditioning, cooling requirements for summer comfort, efficiency of fuels with stoker firing, performance of oil fired furnaces, and studies of vacuum pump operation.

There will be entertainment for everybody and a special program for the ladies.

A Get-Together-Party for dinner, entertainment and dancing is planned for Monday evening and all members, ladies and guests are invited.

The feature event for Tuesday evening will be the 43rd Annual Banquet and Dance which will include the presentation of the Past-President's emblem to Prof. G. L. Larson and an address by Dr. A. C. Willard, President of the University of Illinois.

After the technical session on Wednesday an inspection trip of the power plant and brewery of Anheuser Busch will be enjoyed.

All railroads are offering low rates to St. Louis from all points in the United States and Canada. Inquiry should be made of local ticket agents for the lowest available round trip rates and fastest schedules to St. Louis.

By arrangement with the air lines the Society has arranged

[*Continued on page* 75]

Method of Choosing Location of, Financing and Conducting Meetings of the Society

Resolved: That inasmuch as the Annual and Semi-Annual Meetings of the Society come under the jurisdiction of the Council, the following rules governing the handling of such meetings be adopted by the Council and published in the JOURNAL of the Society at least twice during every year, preferably just prior to each meeting:

1—The Council will select the city in which the Annual or Semi-Annual Meeting is to be held, giving due consideration to the invitations received from Chapters or members as well as to the advisability of so distributing those meetings as to make them of the greatest advantage to the general membership, and to reduce as far as possible the expense of members attending.

2—That an appropriation be made to cover the entertainment or local expenses, incurred in connection with the meeting not exceeding $500.00, the regular meeting expense to be taken care of by the General Fund of the Society in the regular way.

3—That no registration fee or compulsory obligations of any nature be imposed on members or guests.

4—That the purchase of tickets for banquets or for any other form of entertainment that may be provided be entirely voluntary.

5—That the grouping of features and the sale of tickets for group features be discouraged.

6—That the raising of funds from manufacturers of heating apparatus be discouraged.

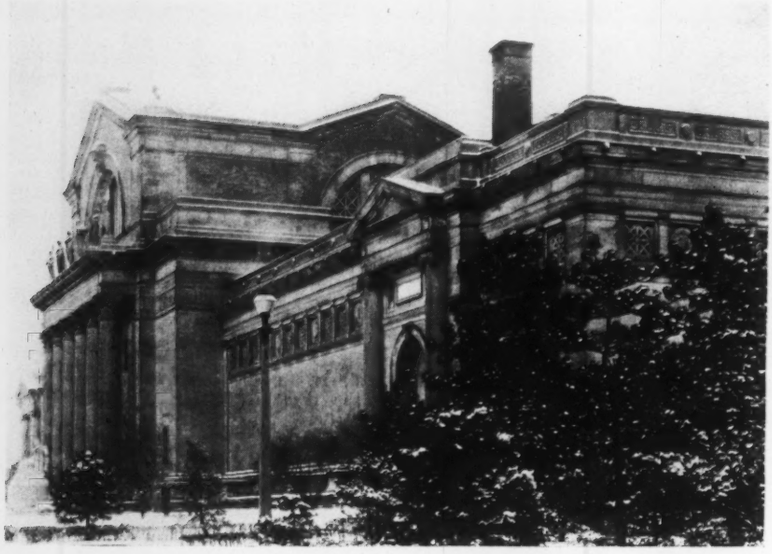
7—That the display of samples, or of literature, advertising the product of any manufacturer in any way, shape or form, be not permitted at the booths, registration desk, or in or about the meetings.

8—That the distribution of trade papers be entirely at the discretion of the committee in charge.

9—That the local Chapter or local members, be empowered to form a General Committee with such sub-committees as may be required to handle the details of transportation, hotel accommodations, entertainment, finance, etc., and that this General Committee be requested to confer frequently with the Council, through the Secretary of the Society, and to make frequent reports on progress in connection with the various matters being handled by them.

10—That the arrangements of elaborate and costly entertainment features be discouraged.

Adopted at Council Meeting, January 29, 1926.



PROGRAM

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Hotel Statler, St. Louis, Mo.

January 25-27, 1937

Technical Events

Sunday, January 24

10:00 a. m. Council Meeting.

Monday, January 25

9:00 a. m. Registration and Reception, St. Louis Chapter Room.
9:30 a. m. Committee Meetings.
10:00 a. m. Conference of Chapter Delegates. *Speakers*—President G. L. Larson, W. A. Russell, W. H. Driscoll, D. S. Boyden.

First Session, Monday, January 25

2:00 p. m. Greeting C. R. Davis, President St. Louis Chapter.
Response by Pres. G. L. Larson.
Reports of Officers and Council.
Reports of Council Committees.
Report of Committee on Research—Lt. Col. W. A. Danielson, Chairman.
Thermal Properties of Concrete Construction by F. B. Rowley, A. B. Algren and Robert Lander.
The Specific Characteristics of Fans by M. C. Stuart and J. B. Lusk.
Report of Tellers of Election.

Second Session, Tuesday, January 26

9:30 a. m. Technical Papers—
Report of Committee on Constitution and By-Laws —R. H. Carpenter, Chairman.
Report of Guide Publication Committee—J. H. Walker, Chairman.
A Rational Method of Duct Design by L. G. Miller.
The Noise Characteristics of Air Supply Outlets by D. J. Stewart and G. F. Drake.
Noise in Ventilating Systems and Methods for its Elimination by J. S. Parkinson.

Third Session, Tuesday, January 26

2:00 p. m. Technical Papers—
Investigations on the Exchanges of Energy Between the Body and Its Environment by Dr. Charles Sheard and Dr. M. M. D. Williams.
Fever Therapy Induced by Conditioned Air by F. C. Houghten, Dr. M. B. Ferderber and Carl Gutberlet.
Cooling Requirements for Summer Comfort Air Conditioning by F. C. Houghten, F. E. Giesecke, Cyril Tasker and Carl Gutberlet.
Report of A.S.H.V.E.—A.S.R.E. Committee on National Standards for Air Conditioning Applications by L. A. Harding.
4:00 p. m. Meeting of Nominating Committee.

Fourth Session, Wednesday, January 27

9:30 a. m. Technical Papers—
Heat Losses and Efficiencies of Fuels in Residential Heating by R. A. Sherman and R. C. Cross.
Performance of Oil-Fired, Warm-Air Furnaces in the Research Residence by A. P. Kratz and S. Konzo.
Condensate and Air Removal Rates in a Vacuum Heating System by D. W. Nelson.
Installation of Officers.
Unfinished Business.
New Business.
Resolutions.
Adjournment.
12:30 p. m. Council Luncheon and Meeting.

Entertainment Events

Monday, January 25

9:00 a. m. Reception and Registration of Members, Ladies and Guests—Roof Garden, Hotel Statler.

12:30 p. m. Get-Together Luncheon for Members, Ladies and Guests.

3-5 p. m. Reception and Tea for Ladies—music and a talk on precious gems.

6:30 p. m. Dinner for Past-Presidents.

7:00 p. m. Dinner for Members, Ladies and Guests—Informal entertainment—Mississippi Levee Levities—a floor show of 10 big acts—music by Al Roth's Orchestra.

Tuesday, January 26

11:30 a. m. Ladies assemble for motor trip to Shaw's Garden and the Jewel Box—luncheon at Garavelli's and visit to Jefferson Memorial to see Lindbergh Trophies.

7:30 p. m. 43rd Annual Banquet and Dance—Ballroom, Hotel Statler—E. B. Langenberg, Toastmaster, Presentation of Past-President's emblem to Prof. G. L. Larson. Speaker—Dr. Arthur C. Willard, President of University of Illinois. Entertainment by vocal artists and music for dancing by Al Roth and his Columbia Broadcasting Band.

Wednesday, January 27

2:00 p. m. Inspection of power plant and brewery of Anheuser-Busch.

[*Continued from page 73*]

for a 15% reduction on published tariffs and cards, for this special rate must be obtained from the headquarter's office of the Society, by members who intend to fly to St. Louis.

Members who are planning to attend the 43rd Annual Meeting should send in hotel reservation cards and make advance reservation for the informal party and annual banquet. It is also suggested that members invite a guest who is interested in some phase of heating, ventilating and air conditioning using the special cards which have been furnished.

Now is the time to prepare for your trip to St. Louis. The Committee on Arrangements awaits your arrival on January 25.

Carrier Honored by Japanese Engineering Societies

On the occasion of the 25th anniversary of the announcement of the psychrometric formula by Willis H. Carrier, past-president of the A.S.H.V.E., a cablegram from Dr. Masao Kamo, Chief Professor of Mechanical Engineering at the Imperial University, Tokio, and President of the Japanese Association of Refrigeration, was received which read as follows:

"In view of the 25th anniversary on December 8 of the presentation of his psychrometric formula, the Japanese Association of Refrigeration has the honor of awarding honorary membership of the society to Dr. Willis H. Carrier."

Similar action was taken by the Board of Directors of the Japanese Society of Domestic and Sanitary Engineers in awarding honorary membership to Mr. Carrier.

Mr. Carrier, who is Chairman of the Board of Carrier Corporation, Newark, N. J., reviewed the subject of psychrometric developments as related to practical engineering problems in air conditioning at the 52nd annual meeting of the *American Society of Mechanical Engineers* early in December.

Messages of congratulations came to Mr. Carrier from noted scientists, engineers and business leaders, including Dr. A. C. Willard, President of the University of Illinois, Dr. Robert A. Millikan, California Institute of Technology, R. B. VonKleinsmid, President of the University of Southern California, and former President of the United States, Herbert Hoover.

Dr. D. S. Jacobus Receives Morehead Medal

Dr. D. S. Jacobus, advisory engineer for The Babcock & Wilcox Co., received the Morehead Medal for the year 1935 for his outstanding leadership in the formation of codes and procedures, which have made fusion welding acceptable. The Morehead medal is awarded annually by the *International Acetylene Association.*

Dr. Jacobus is a Life Member of the A.S.H.V.E. and a Past President and Honorary Member of the *A.S.M.E.*

Furnace Manufacturers Meet in Chicago

A successful two-day meeting was held by the *National Warm Air Heating and Air Conditioning Association,* Stevens Hotel, Chicago, Ill., December 16 and 17. Registration totaled 450 and among the outstanding addresses were those of Bennett Chapple on the Opportunities in Air Conditioning, Gale Sullivan of the Federal Housing Administration, and A. P. Lamneck, Congressman from Ohio, who discussed the Robinson-Patman Act.

The report of the Research Advisory Committee was given by Fred Sedgwick, Minneapolis, and the report of the Code Committee was given by the Chairman, Prof. J. D. Hoffman, Lafayette, Ind. An outline of the research activities at the University of Illinois was presented by Prof. A. P. Kratz and S. Konzo. A brief address was made by Prof. G. L. Larson, President of the A.S.H.V.E.

The officers elected for 1937 are as follows: W. L. Rybolt, President; L. R. Taylor, 1st Vice Pres.; C. A. Olsen, 2nd Vice Pres., and Allen W. Williams, Managing Director and Treasurer.

Refrigerating Engineers Meet in New York

The 32nd Annual Meeting of the *American Society of Refrigerating Engineers* was held in the Hotel Pennsylvania, New York, December 2 to 4, and the discussion and papers were devoted to air conditioning, thermal problems, commercial refrigeration and absorption methods.

The officers chosen for the coming year are as follows: H. M. Williams, Dayton, Ohio, *President;* Crosby Field, New York, *First Vice-President;* Gardner Poole, Boston, Mass., *Second Vice-President;* George Hulse, New Haven, Conn., *Treasurer,* and D. L. Fiske, New York, *Secretary.*

Power Show Held in New York

The 12th National Exposition of Power and Mechanical Engineering attracted many thousands to Grand Central Palace during the week of November 30 to December 5, and on the three floors there were exhibits of power plant and industrial machinery and accessories used in every branch of mechanical engineering.

The exhibit was under the personal direction of Charles F. Roth and 300 firms had exhibits.

Oil Burner Exhibit Announced

Announcement has been made by G. Harvey Porter, Managing Director of the *Oil Burner Institute* that a National Oil Burner and Air Conditioning Exposition will be held at the Commercial Museum, Philadelphia, Pa., March 15 to 19, 1937.

At the same time the *Institute* will hold its meeting at the Benjamin Franklin Hotel.

Engineers' Council Gets Carnegie Appropriation

On October 22, 1936, the trustees of the Carnegie Corporation of New York resolved that "the sum of $16,000 be, and it hereby is appropriated to the Carnegie Foundation for the Advancement of Teaching, toward support of the program of the Engineers' Council for Professional Development."

Continued Carnegie interest in engineering activities is thus once again evidenced. It began in 1903 with a donation of $1,050,000 by Mr. Carnegie for erection of the Engineering Societies Building at 33 West 39th St., New York City. In later grants the Carnegie Corporation has generously supported the *Society for the Promotion of Engineering Education* in its investigation of engineering schools extending over a period of five years as well as the summer schools for engineering teachers instituted and maintained by that organization.

The present $16,000 grant is made in support of the work of the Engineers' Council for Professional Development (E. C. P. D.) for the year October 1, 1936, to September 30, 1937. Additional appropriations in the amount of $3,450 have been made to Council by the Engineering Foundation. Rental cost for Council's office recently opened in the Engineering Societies Building is expected to be met by three of the participating societies, the *American Society of Mechanical Engineers,* the *American Society of Civil Engineers,* and the *American Institute of Electrical Engineers.* Including this rental value a total fund of over $21,000 is available, of which $19,450 will be applied directly to the advancement of Council's program for enhancing the professional status of the engineer through the cooperative support of the national organizations directly representing the professional, technical, and legislative phases of the engineer's life.

In connection with the newly opened office of E. C. P. D., R. I. Rees is devoting full time to his duties as vice-chairman of the Council.

The Air Hygiene Foundation of America

The Air Hygiene Foundation of America is an alliance of industry and science which seeks to eliminate or control industrial diseases caused by air pollution. Of special interest is silicosis, which endangers the health of workmen and the investments of industry.

Leaders in steel, mining, glass, foundry, refractories, ceramics, the quarry, and kindred interests, realizing the need for cooperative action in facing the industrial problem, organized the Air Hygiene Foundation of America last year.

It was incorporated in Ohio in December, 1935, and several days later a comprehensive program involving correlation and dissemination of factual information and the support of pertinent research was inaugurated at Mellon Institute of Industrial Research, Pittsburgh. Due to lack of knowledge concerning some phases of pneumoconiosis, the need for immediate scientific investigation in the field, before anything lasting could be planned or accomplished, is readily apparent.

The purpose of the research program, upon which work is under way, is the elimination or reduction to safe concentrations in plants and industrial operations, of dusts and fumes known or suspected to be harmful to those inhaling them.

The Foundation is a non-profit cooperative movement, seeking to safeguard employer and employee from health and economic hazards in industry, particularly in the so-called dusty trades.

The first step toward this goal necessitates the collection of all available data on the subject, knowledge which has accumulated in many places through the years but which has not been assembled, evaluated and unified into a compact useful body of information. The gathering together and weighing of this knowledge is essential before an intelligent course of research can be charted.

H. B. Meller, managing director, is a former Dean of Mining at the University of Pittsburgh and an authority on air pollution. He comments in a recent message to Foundation members as follows:

> The average employer is quite willing that the balance of favor shall be with the employee. But just where is that balance? I don't think we know.
>
> Differences of opinion between medical men, the absence of completely satisfactory methods of determining dust diseases in the early stages, the racketeering aspects that have been injected, would tend to show that there is need for additional scientific information in order most intelligently to deal with the problems of prevention and of adequate and fair legislation.
>
> With this in mind the Air Hygiene Foundation started its program of research—pathological, physical, chemical, engineering, and legal, in which each of the theories and opinions thus far advanced will be tested for accuracy.
>
> The results of the Foundation's program will be measured in increased efficiency and longer productive life for workmen in the so-called dusty trades, in more adequate protection for those who have and may be injured, and in a better understanding between industry and labor.

The Foundation is now engaged in this far-reaching undertaking, gathering together all pertinent facts relating to pneumoconiosis in the fields of Medicine, Engineering, and Law.

This work is under the supervision of Mr. Meller and three major committees, medical, engineering, and legal.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

CLEVELAND: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* L. T. AVERY, 2341 Carnegie Ave. *Secretary,* W. R. BEACH, 75 Public Sq.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* E. B. ROYER, 6635 Iris Ave. *Secretary,* K. W. SCHICK, 561 Reading Rd.

ILLINOIS: *Organized,* 1906. *Headquarters,* Chicago. *Meets,* Second Monday in Month. *President,* J. J. HAYES, 53 W. Jackson Blvd. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* L. R. CHASE, 2440 Pennway. *Secretary,* F. J. DEAN, JR., 6028 Walnut St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg, Man. *Meets,* Fourth Thursday in Month. *President,* J. B. STEELE, 184 Waterloo St. *Secretary,* C. H. TURLAND, 325 Centennial St.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston. *Meets,* Second Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* JOHN TURNER, 285 Columbus Ave.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis. *Meets,* Second Monday in Month. *President,* N. D. ADAMS, 220 Second Ave. S. W., Rochester, Minn. *Secretary,* J. E. SWENSON, 800 Hennepin Ave.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit. *Meets,* First Monday after the 10th of the Month. *President,* R. K. MILWARD, 127 Campbell Ave. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids. *Meets,* Second Monday in Month. *President,* L. G. MILLER, Mich. State College, E. Lansing, Mich. *Secretary,* E. I. ADAMS, 115 So. Pine, Lansing, Mich.

MONTREAL: *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Second Monday in Month. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York. *Meets,* Third Monday in Month. *President,* G. E. OLSEN, 101 Park Ave. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo. *Meets,* Second Monday in Month. *President,* P. S. HEDLEY, Curtiss Bldg. *Secretary,* C. A. GIFFORD, 247 North Dr.

OKLAHOMA CITY: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *President,* F. X. LOEFFLER, 1604 N. W. Fifth St. *Secretary,* E. W. GRAY, Box 1498.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* THOMAS MCDONALD, 117 Peter St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* S. D. PETERSON, 473 Colman Bldg. *Secretary,* D. C. GRIFFIN, Orpheum Bldg.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia. *Meets,* Second Thursday in Month. *President,* W. F. SMITH, 422 Bryn Mawr Ave., Cynwyd, Pa. *Secretary,* H. H. ERICKSON, 804 Architects Bldg.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis. *Meets,* First Tuesday in Month. *President,* C. R. DAVIS, 2328 Locust St. *Secretary,* R. J. TENKONOHY, 3650 Shaw Blvd.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles. *Meets,* Second Tuesday in Month. *President,* LEO HUNGERFORD, 524 Loew's State Bldg. *Secretary,* H. M. HENDRICKSON, 5051 Santa Fe Ave.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* F. E. GIESECKE, Texas A. & M. College. *Secretary,* W. H. BADGETT, Texas A. & M. College.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* W. A. DANIELSON, 2236 Munitions Bldg. *Secretary,* M. D. KICZALES, 3000 Connecticut Ave., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee. *Meets,* Third Monday in Month. *President,* M. E. ERICKSON, 8405 W. Greenfield Ave., West Allis, Wis. *Secretary,* R. G. KOCH, 626 E. Wisconsin Ave.

Texas Chapter Organizes and Elects Officers

Activities of the Texas Chapter of the A.S.H.V.E. were formally inaugurated on December 19, 1936, when the first meeting was held at College Station, Tex. A very pleasant and profitable evening was enjoyed by those present.

The following officers were elected for the term ending at the annual meeting in May, 1937:

President—F. E. Giesecke.
Vice-President—R. F. Taylor.
Secretary—W. H. Badgett.
Treasurer—I. E. Rowe.
Board of Governors—J. A. Kiesling, M. L. Diver, C. L. Kribs, Jr.

R. K. Werner was chosen as delegate to the Annual Meeting of the Society in St. Louis and as representative on the A.S.H.V.E. Nominating Committee, with W. E. Long as alternate.

Many telegrams and letters were received from officers and members of the Society's Council and friends and were appreciated by Texas Chapter.

Washington D. C. Chapter Hears Talks on Fans, Greenhouses, and Gas Heating

December 9, 1936. Twenty-two members and guests of Washington D. C. Chapter attended dinner and 35 were present at the meeting following, which was held at the Harrington Hotel. The business session was called to order by Pres. W. A. Danielson at 8:00 p. m., and minutes of the preceding meeting were read and approved. Sec. M. D. Kiczales read a report of the proceedings of the *District of Columbia Council of Engineering and Architectural Societies* at its meeting, November 6, 1936.

An invitation was extended from the Washington Section of the *A.S.M.E.* to hear an address to be delivered by H. F. Hagen, B. F. Sturtevant Co., on Fan Design, Specification and Operation, at its December 10 meeting.

President Danielson announced that the next meeting would be held at the Walter Reed General Hospital, when a paper would be presented on the air conditioning installation in the operating rooms and recovery wards, and the vaccine preparation laboratory's installation, followed by an inspection tour. At this meeting, President Danielson said that a paper would also be given on Cooling Requirements for Summer Comfort Air Conditioning, followed by a discussion of the Society's research on this subject during the past summer.

T. H. Urdahl brought to the attention of the members that the date of the meeting, December 9, 1936, was the twenty-fifth anniversary of the beginning of air conditioning. The development of this industry was initiated by the presentation of a paper by W. H. Carrier on the relative effects of temperature and humidity. On motion of Mr. Urdahl, duly seconded and passed, it was unanimously,

RESOLVED, That the Washington D. C. Chapter express to Willis H. Carrier the sincere appreciation of the entire membership of the work which, through his initiative and application, has been largely responsible for the development of the air conditioning industry, and extend to him its greetings and best wishes on the occasion of the silver anniversary of his initial efforts.

After some discussion it was voted that copies of the resolu-

tion of Northern Ohio Chapter, relative to the collection of chapter dues by the Society's Council should be sent to members of Washington, D. C. Chapter for careful consideration prior to the next meeting.

President Danielson then introduced L. F. Nordine, The Trane Co., who gave an illustrated talk on Greenhouse Heating. Mr. Nordine related his experience and the data he had obtained in Minnesota, and discussed methods employed for proper plant propagation under various weather conditions, fuel consumption, and piping layouts. During the discussion following, various members of the chapter told of their experiences in greenhouse heating, and among them were R. H. Feltwell and Mr. Senner. Mr. Senner mentioned his recent experiences in large greenhouse designing for the Department of Agriculture. A rising vote of thanks was given to Mr. Nordine for his instructive talk.

November 11, 1936. The Washington D. C. Chapter held its regular meeting at the Hotel Harrington with 28 members and guests present for dinner and 50 at the meeting following. The Chapter had as its guests, A. R. Dunham and E. G. Beeson, C. A. Dunham Co.

Mr. Feltwell, outgoing chairman of the Membership Committee, reported the application of P. H. Loughran, Jr., and E. H. Lloyd, the new membership chairman outlined the proposed program of the Committee.

President Danielson introduced G. F. Miller, C. A. Dunham Co., Washington, D. C., who spoke on A Revolutionary Principle in the Design of a Gas Heating Unit. Mr. Miller illustrated his talk with charts and slides, and showed the construction and operation of a gas heating boiler, in which the gases of combustion are brought into the dome through the piping system and exhausted by means of a mechanical exhauster at the end of the return line. The ensuing discussion was very interesting, and Mr. Dunham aided Mr. Miller in answering questions relative to the tests, efficiencies, construction and ratings of this unit.

Cooling Requirements for Summer Air Conditioning Reviewed by Illinois Chapter

December 14, 1936. The regular monthly meeting of the Illinois Chapter was held in the Crystal Room of the Hotel Sherman, and was called to order by Pres. J. J. Hayes at 8:00 p. m. with an attendance of 112.

Tom Brown, chairman of the Membership Committee, announced the applications of A. S. King, C. C. Schuetz, and H. C. Shilling, who were welcomed into the Chapter.

After reading the minutes of the November meeting, Secy. C. E. Price presented a communication from the Illinois Central Railroad offering party rates and special coaches on the Green Diamond from Chicago to St. Louis for those attending the A.S.H.V.E. Annual Meeting in January.

The meeting was devoted to a review and discussion of the A.S.H.V.E. Research Laboratory paper, Cooling Requirements for Summer Comfort Air Conditioning. John Howatt reviewed this Annual Meeting paper and with the aid of slides, explained the important findings of research conducted on this subject during the past summer.

Mr. Howatt explained that this was a continuation of the work done along similar lines a year ago, with the scope of the studies broadened to include Toronto and Texas in addition to Pittsburgh. Charts plotted the relation between effective temperature and feeling of warmth of subjects in Toronto, Texas and Pittsburgh, and findings indicated that comfort may be had over a small effective temperature range.

In order to minimize the cold shock upon entering a conditioned space, an optimum effective temperature for air conditioning purposes was recommended near the upper limits of the comfort zone, or 70 deg effective temperature for Toronto and 73 deg for localities having summer conditions as hot or hotter than Pittsburgh.

The study of the relation of comfort to relative humidity with constant effective temperature indicated little or no measureable variation in the time required for perspiration to disappear and for comfort to be established in a relative humidity range from 20 to 90 per cent.

Clothing was found to have a material effect on the desired temperature for comfort.

The leading criticism of the paper, in the discussion which followed, was that the data developed were not adapted for use in the field. J. J. Aeberly pointed out that wet bulb, dry bulb and dew point temperatures are the factors which are used in practice, not effective temperature or *feeling of warmth* and Mr. Aeberly recommended that such studies in the future get down to basic values.

In a discussion submitted by E. P. Heckel, which was read by Mr. Bodinus, the research studies were complimented as being of value in providing definite data on shock or reaction to change in going in and out of conditioned spaces and something definite on effective temperature which would be helpful in designing for economical operation.

Mr. Bodinus commented on the lack of effect of humidity on the feeling of comfort, expressing his opinion that a measurement of this effect by the disappearance of perspiration did not take into account the perspiration in the clothes of the subject or the perspiration generating system of each individual. He also felt that we need more information on air motion and its effect in studies of this sort.

V. L. Sherman thought that barometric pressures were important and should be considered in these studies.

S. I. Rottmayer felt that, with all the variables entering into such a subject, effective temperature was as good a measure as any and F. I. Raymond stated that he believed effective temperatures might be used as a guide in design if relative humidity is limited to a range between 30 and 70.

Before adjourning the meeting, President Hayes remarked with pleasure on the number of past presidents who were present. At his request eleven past presidents arose as an example to the chapter of continued interest in its activities.

Local Research Needs Brought to Attention of Southern California Chapter

November 10, 1936. Fifty-two members and guests of Southern California Chapter were present at the Rosslyn Hotel for a luncheon and meeting.

Pres. Leo Hungerford presided at the business meeting and invited all those connected with the heating, ventilating and air conditioning industry to join the A.S.H.V.E. if they have not already done so. Mr. McBeanfield announced the meeting of the Los Angeles Engineering Council in joint session with the *A.I.E.E.* at the University of Southern California.

E. H. Kendall was called upon to introduce Dean B. M. Woods, Department of Mechanical Engineering, University of California at Berkeley, who was the principal speaker. Dean Woods discussed the subject of Important Research Problems in Air Conditioning, and mentioned that the following subjects offer fertile fields for research in the air conditioning industry: 1. More accurate determination of what comfort consists of; 2. Control systems and control instruments; 3. Evaporative cooling and humidifying devices in homes; 4. Cooling towers.

The meeting adjourned at 1:35 p. m. according to the report of Secy. H. M. Hendrickson.

October 13, 1936. Luncheon was served the 46 members and guests of the Southern California Chapter who attended a meeting at the Rosslyn Hotel at which Pres. Leo Hungerford presided. O. W. Ott, chairman of the Chapter's Committee on Research, spoke a few words on the desirability of Southern California Chapter engaging in or sponsoring some research of particular value to the local section. Mr. Ott introduced Frank Park who told of a course in Elementary Heat Transfer being given at Los Angeles Junior College by Prof. L. Boelter

of the University of California at Berkeley. Mr. Park also stated that Professor Boelter and his associates were interested in cooperating with the Southern California Chapter in research and mentioned that studies on cooling towers and surface cooling would be of particular value.

W. E. Barnum, Jr., chairman of the Membership Committee, and President Hungerford, each stressed the necessity of obtaining new members.

The chairman of the Program Committee, Mr. Kendall, briefly outlined plans for future meetings. Mr. Armstrong of the Southern California Edison Co. spoke of the air conditioning meeting sponsored by the power companies, which was held at the Roosevelt Hotel, Hollywood, October 16.

A. J. Hess, air conditioning engineer in the office of E. L. Ellingwood, was then introduced and gave an interesting talk on The Progress and Development of Air Conditioning in the Past Ten Years.

Massachusetts Chapter Is Host to Pres. G. L. Larson

November 13, 1936. Pres. G. L. Larson of the A.S.H.V.E., Madison, Wis., was the guest of honor at the November dinner and meeting of the Massachusetts Chapter held at Walker Memorial, Massachusetts Institute of Technology.

The Chapter had a fine meeting in honor of President Larson's visit, and almost 100 members and guests were present. The Air Conditioning Bureau and the *E. S. N. E.,* who were notified of the meeting and invited to participate in welcoming President Larson, gave splendid cooperation.

President Larson was introduced by D. S. Boyden, first vice-president of the A.S.H.V.E., and W. T. Jones, past-president of the Society, and spoke on the Economics of Good Construction in Residence Heating and Air Conditioning. The lecture was extremely interesting to the group of engineers present, engaged in many fields of endeavor, and the hope was expressed that the data that President Larson presented might appear in printed form.

Secy. John Turner reports that a general discussion followed of the various points brought out by the speaker in his talk.

Research Laboratory Paper Discussed by Cleveland Chapter

December 14, 1936. The meeting was held at the Cleveland Club and was attended by 75 members and guests, and was preceded by a dinner meeting when 27 were present.

E. B. Carey reported for the Membership Committee that Messrs. Kofoed and Sogg had applied for membership, and that Messrs. Porter, Fleming, Gall, Taze, and Bartholomew had applied as local affiliates. They were unanimously accepted.

W. M. Rowe explained the new Northern Ohio affiliate blank then in the process of printing, and Prof. G. L. Tuve reported for the Education and Publicity Committee. H. E. Wetzell gave an outline prepared by the Standards Committee which was accepted, and Mr. Wetzell was instructed to proceed and prepare complete standards for presentation in the near future.

Pres. L. T. Avery turned the meeting over to C. F. Eveleth who introduced the speaker of the evening, F. C. Houghten, director of the A.S.H.V.E. Research Laboratory at Pittsburgh, Pa.

Mr. Houghten presented the results of research work which has been carried on in College Station, Tex., Toronto, Can., and Pittsburgh, Pa. He pointed out that some of the work was quite conclusive, yet there is much more to be done in establishing comfort cooling standards for older people and different conditions of clothing, occupation, etc. The effective temperature has been well established and should be higher in Texas than in Toronto or Pittsburgh for equal comfort. Mr. Houghten pointed out that 73 deg effective temperature is the higher part of the summer comfort zone for the Northern Ohio territory and should be used as the local standard because of greater economy in installation and operating cost.

A lively discussion followed in which matters of air speed, turbulence, and high and low relative humidities were brought to the attention of the meeting.

Secy. W. R. Beach has reported that President Avery announced the subject of the January meeting to be "Controls."

Engineering and Air Conditioning Problems of Manitoba Plant Discussed by Chapter

November 26, 1936. The meeting of Manitoba Chapter was held at the Fort Garry Hotel and minutes of the previous meeting were read and adopted.

D. F. Michie presented a report of the committee working on Chapter 5 of THE A.S.H.V.E. GUIDE for approval, and R. L. Kent suggested that more information be made available relative to figuring heat transfer coefficients at different wind velocities for various surfaces.

Secy. C. H. Turland reported on tentative arrangements for the Annual Chapter Banquet December 12, which the meeting approved.

It was moved by F. Thompson and seconded by G. C. Davis that the Manitoba Chapter unanimously support the Cleveland Chapter's resolution to the A.S.H.V.E. Council regarding Chapter dues.

Prof. N. M. Hall, University of Manitoba, was guest speaker and presented a comprehensive survey of engineering and air conditioning problems encountered in the development of the Hudson Bay Mining and Smelting Co.'s plant at Flin Flon, Manitoba, which was keenly appreciated and brought to a close a very interesting meeting.

Automatic Temperature Regulation Subject of Ontario Meeting

December 7, 1936. 57 members and guests of the Ontario Chapter were present for dinner served at 6:30 p. m. at the Royal York Hotel. W. P. Boddington acted as chairman of the meeting in the absence of Pres. Thomas McDonald. Following dinner, Mr. Boddington announced that the next meeting would occur on January 11.

The chairman then called on the principal speaker of the evening, Mr. Mueller, who gave an illustrated talk on Automatic Temperature Regulation for Summer and Winter Air Conditioning, and following the address there was an interesting discussion covering the points discussed by the speaker.

Mr. Evans extended a vote of thanks on behalf of the Ontario Chapter to Mr. Mueller for his splendid address, according to the report of Secy. H. R. Roth.

Kansas City Chapter Discusses Combustion

November 16, 1936. The second fall meeting of Kansas City Chapter was held at the Newbern Hotel with 18 members present for dinner.

Pres. L. R. Chase presided and announced the appointment of D. D. Zink as chairman of the Membership Commitee.

President Chase outlined a plan for cooperation between the Engineers Club of Kansas City and local chapters of national societies in a joint action of these groups to obtain nationally known speakers on general engineering topics. He mentioned that this type of organization was operating successfully in other cities. The first meeting, sponsored by this group, was held November 24, at which time a paper on the San Francisco-Oakland Bay Bridge was presented.

It was voted that the Kansas City Chapter accept the proposal of the Engineers Club, and it was agreed that President Chase was to represent the Chapter in any committee meetings of the new organization.

The guest speaker of the evening was O. S. Hubbard, Hubbard Sales Co., who was introduced by E. K. Campbell. Mr. Hubbard presented an interesting discussion on combustion and outlined the general chemical reactions taking place in this process. He discussed the method of firing a boiler and the relative advantages of yellow and blue flame fire. In a discussion on Orsat analysis, it was pointed out by the speaker that the accuracy of this method is questionable in small fires because combustion is not always complete in small combustion chambers.

After a short discussion the meeting adjourned, according to the report of Secy. F. J. Dean, Jr.

Air Conditioning Subject of Philadelphia Chapter Meeting

December 10, 1936. Philadelphia Chapter held its regular meeting at the Engineers Club at 8:15 p. m. ,and Pres. W. F. Smith presided. The turnout for this meeting was most gratifying with 125 members and guests present for the meeting and 47 at dinner.

Minutes of the previous meeting and the treasurer's report were read and approved.

A. E. Kriebel, chairman of the Membership Committee, reported two new members—H. C. Cody and H. B. Hedges. C. B. Eastman, chairman of the Meetings Committee, introduced the speaker of the evening, C. S. Leopold, Consulting Engineer, who spoke on The Various Types of Air Conditioning Systems.

Mr. Leopold's talk, in which he compared various types of systems and reasons for their selection, proved to be exceptionally interesting and instructive. In an informal manner, Mr. Leopold described the air conditioning systems of several department stores in different sections of the country and gave some interesting comparative figures on installations and operating costs.

H. P. Gant proposed a rising vote of thanks to Mr. Leopold, and Secy. H. H. Erickson has reported that President Smith adjourned the meeting at 10:00 p. m.

Noise, Air Conditioning Standards, and Warm Air Heating Discussed by Western Michigan

December 14, 1936. The regular meeting of Western Michigan Chapter was held in the Berkey and Gay Room of the Rowe Hotel, Grand Rapids, with 35 members and guests present.

The Nominating Committee proposed the name of W. W. Bradfield as vice-president to fill the unexpired term of J. H. Van Alsburg, who recently moved to the Chicago district, and Mr. Bradfield was unanimously elected.

S. P. Walker, U. S. Gypsum Co., was the first speaker of the evening, and his talk on Noise Abatement was illustrated with slides and demonstrations of equipment, and was enthusiastically received.

Prof. Edward Anderson briefed the A.S.H.V.E. Research Laboratory paper, Cooling Requirements for Summer Comfort Air Conditioning. After a discussion, in which the entire group participated, it was voted that the discussion be continued at the January meeting.

E. A. Scott, editor of The Sheet Metal Worker, was a guest of the meeting and responded briefly to an invitation to address the group.

November 16, 1936. Pres. L. G. Miller called the Western Michigan Chapter meeting to order at the Hotel Rowe, Grand Rapids, with 14 members and 10 guests present. Following the regular business, letters of resignation from D. L. Taze and J. H. Van Alsburg were read by Secy. E. I. Adams. It was voted that Secretary Adams send letters to Messrs. Taze and Van Alsburg, expressing regret at their leaving and appreciation for their good work in and for the Chapter.

B. F. McLouth, chief engineer, Dail Steel Products Co., Lansing, Mich., was the speaker of the evening and gave a detailed report on the Forced Warm Air Heating Code.

President Miller was elected Chapter representative on the Society's Nominating Committee to attend the A.S.H.V.E. Annual Meeting in St. Louis.

A Nominating Committee was appointed to present a candidate for vice-president to fill the unexpired term of Mr. Van Alsburg.

Pittsburgh Chapter Elects Officers and Discusses Cooling Standards

December 14, 1936. Thirty-five members and guests of Pittsburgh Chapter sat down to dinner in the Norse Room of the Fort Pitt Hotel at 6:45 p. m.

Pres. R. J. J. Tennant called the meeting to order to take care of the routine business and Secy. T. F. Rockwell read the minutes of the November meeting, which were approved.

Treas. J. F. Collins, Jr. gave his annual report and F. C. McIntosh, chairman of the Membership Committee, reported a gain of 7 Members, 1 Associate Member, 4 Junior Members, and 6 Student Members in the Pittsburgh district for 1936.

Speaking for the Air Conditioning Code Committee, President Tennant stated that no further action would be taken until the report of the Society's Committee was released.

Secretary Rockwell read a copy of the letter to the A.S.H.V.E. Council on Chapter dues as authorized at the November meeting.

Chairman L. B. Pittock of the Nominating Committee presented the committee's candidates for chapter officers and, as there were no further nominations from the floor, it was moved that the Secretary be directed to cast a unanimous ballot for the slate presented. This motion was passed and the following Chapter officers were elected for 1937:

President—M. L. Carr.
Vice-President—J. F. Collins, Jr.
Secretary—T. F. Rockwell.
Treasurer—J. E. McLean.
Board of Governors—R. J. J. Tennant, R. A. Miller, Arthur McGonagle.

Before relinquishing the chair, Mr. Tennant, retiring president, reviewed the activities of the year and made the following recommendations: (1) that the degree-day committee be continued; (2) that the current-events committee be continued so that students may have some contact with the Chapter; (3) that a transcript of discussion following presentation of technical papers be made available for distribution to members; and (4) that more meetings be held in downtown Pittsburgh.

Mr. Tennant then turned the meeting over to President Carr, who made a few remarks concerning his administration before taking up the new business.

It was moved by Mr. Tennant and seconded by Mr. Pittock that President Carr act as representative of the Pittsburgh Chapter at the annual meeting of Chapter officers and that he also serve as representative on the Society's Nominating Committee.

Mr. Tennant introduced Councilman George Evans, the speaker of the evening. Mr. Evans described a trip he had taken through Africa during the summer of 1936, travelling by boat from Gibraltar to Capetown and stopping at a number of ports. During his time in South Africa Mr. Evans visited gold and diamond mines, as well as a large game preserve. Following this he journeyed northward through Central Africa, visiting Victoria Falls and the Pyramids in the Nile Valley. After his entertaining description of the trip, Mr. Evans exhibited many moving pictures.

November 16, 1936. The meeting was called to order by Pres. R. J. J. Tennant in the auditorium of the U. S. Bureau of Mines with an attendance of 20 members and guests. Secy. T. F. Rockwell read the minutes of the May and October meetings, which were approved.

J. F. Collins, Jr., gave the treasurer's report and M. L. Carr, chairman of the Program Committee, outlined the technical program for the December and January meetings.

Reporting for the Air Conditioning Code Committee, President Tennant stated that at a recent meeting of the Committee, the cooperation of the Better Business Bureau had been obtained for bringing the proposed code to the attention of the buying public.

Chairman L. B. Pittock of the Nominating Committee proposed the candidates for Chapter officers for 1937 who were elected in December:

Secretary Rockwell read a communication from headquarters' office relative to the recent action of the Council in regard to the expenses of Chapter delegates to the Society's Annual Meeting. Appointment of a Chapter representative was deferred until the December meeting.

Secretary Rockwell read a letter from the Cleveland Chapter to the Society's Council relative to the collection of Chapter dues. After a brief discussion, it was moved by F. A. Gunther that Secretary Rockwell draw up a similar petition putting the Pittsburgh Chapter on record in favor of the proposal.

President Tennant then introduced F. C. Houghten, Director of the Society's Research Laboratory, Pittsburgh, Pa., who reviewed the results obtained from the Laboratory's research project carried on during the past summer on Summer Cooling Standards. Studies were carried on in Toronto, Ont., Pittsburgh, Pa., and College Station, Texas.

It was fairly well established by research that a constant effective temperature is a better standard than a constant dew point. Shock is experienced by all persons upon entering a cool space and the severity of the shock depends on the person's feeling of warmth before entering the space.

The many questions which were asked Mr. Houghten at the conclusion of his talk showed the keen interest of those present.

Summer Comfort Standards Subject of Michigan Meeting

December 14, 1936. The regular December meeting of Michigan Chapter was held at the Wardell Hotel at 6:30 p. m. with approximately 85 members and guests present.

After dinner, Pres. R. K. Milward introduced the Ford Mountaineers, who entertained in their characteristic manner.

S. S. Sanford, Detroit Edison Co., was presented and discussed Cooling Requirements for Summer Comfort Air Conditioning, a paper prepared by the Society's Research Laboratory. Mr. Sanford outlined the progress of summer cooling comfort studies conducted by the Laboratory and he pointed out that this paper was a report of simultaneous studies carried on at the Laboratory in Pittsburgh, Pa., at Texas A. & M. College, College Station, Tex., and the Ontario Research Foundation, Toronto, Ont. According to the results of these studies, the optimum effective temperature for maximum summer comfort varies with geographical locations: 70 F effective temperature being the optimum for Toronto, while 72 to 73 F is optimum for Pittsburgh, and 73 F for Texas. The report also pointed out that relative humidity had little effect upon comfort so long as the effective temperature did not vary.

After Mr. Sanford's presentation, the following people discussed the results of the paper: Prof. F. J. Linsenmeyer, D. A. Newton, W. Stewart, E. M. Harrigan, Jr., G. B. Helmrich, and W. C. Randall.

President Milward thanked Mr. Sanford for his splendid presentation and the meeting was adjourned at 10:00 p. m. according to the report of Secy. G. H. Tuttle.

Oklahoma Chapter Reviews Comfort Air Conditioning Standards

December 14, 1936. Pres. F. X. Loeffler called the regular meeting of Oklahoma City Chapter to order at 8:00 p. m. in the electric bungalow of the Oklahoma Gas & Electric Co., with 18 members present. The minutes of the previous meeting were read and approved.

Vice-Pres. E. F. Dawson gave an interesting and complete discussion of the Research Laboratory paper, Cooling Requirements for Summer Comfort Air Conditioning, which analyzed the results of studies at Toronto, Ont., Pittsburgh, Pa., and College Station, Tex. The members then joined in a discussion of the paper and many interesting viewpoints were brought out. The general conclusion was that much work still needs to be done in determining the actual effect of variations of humidity, as local results have indicated that for a given effective temperature, the relative humidity has a greater effect on the feeling of comfort than is indicated by the laboratory research. According to the report of Secy. E. W. Gray, the opinion was also voiced that further research should be conducted to determine what brings about the shock experienced by subjects when entering or leaving a conditioned space, and the severity of the shock as related to the physical condition of the subject.

The matter of local standards for air conditioning was discussed and it was moved by A. A. Hoppe and seconded by Professor Dawson that the Chapter adopt such standards as soon as possible. The motion was carried unanimously, and it was voted to send a copy of the summary sheet and standards to all members so that they might forward their written comments to S. L. Rolland, chairman of the committee, in order that suggested changes might be made and the material submitted in a more complete form at the next meeting.

It was decided to set the meeting time at 8:00 p. m. in order to enable members to be present.

V. W. Cherven

Word has been received of the passing of Victor Walter Cherven, of Holland, Mich., on October 3, 1936, at Battle Creek Sanitarium. At the time of his death, Mr. Cherven was chief heating engineer of Holland Furnace Co., with which he had been associated since 1918.

He was born in Budapest, Hungary, on September 24, 1892, and he came to America with his family about 30 years ago. He received his technical education at the Armour Institute of Technology, Chicago, Ill.

From 1909 to 1916 Mr. Cherven served as civil engineer with the Illinois Central Railway, Chicago, and from 1916 until 1917 with the Chicago and North Western Railroad. He then was affiliated from 1917 to 1918 with the Harvey Foundry Co., Harvey, Ill., and Marshall-McClintock Construction Co., Chicago. His association with the Holland Furnace Co. began in 1918 as assistant engineer, and later as heating engineer he was chief inspector of all warm air projects for the United States Housing Corp., Washington, D. C. His work included the design of all heating and ventilating plants and instruction of members of the sales engineering staff.

Mr. Cherven was highly respected, honored, and loved by the management, office personnel, and the field organization of the Holland Furnace Co. His assistance and concern over each branch's problems, his suggestions, and his consideration of the offices of the company and the customers' welfare, as well as his many letters and informative articles were of considerable assistance and appreciated by all of his associates.

Mr. Cherven joined the American Society of Heating and Ventilating Engineers in 1920, and the Officers and Council of the Society sincerely regret his untimely death and extend their sympathy to his widow and four children who survive.

R. J. Millar

Although the death of Rowland J. Millar occurred on July 12, 1936, it was not until recently that this news was reported. Mr. Millar had been suffering from a heart ailment and the intense heat of the summer aggravated the condition.

Mr. Millar was vice-president and general manager of the

Pease Foundry Co., Ltd., and was a well-known figure to members of the heating industry in Canada, where he made regular trips through the western provinces each year. He joined the A.S.H.V.E. as a Member in 1925 and was greatly interested in affairs of Ontario Chapter.

Born at London, Ont., March 27, 1868, Mr. Millar was associated with the Gurney Foundry Co., Toronto, from 1886 to 1890, with the Detroit Stove Works, Detroit, Mich., from 1891 to 1904, and his connection with Pease Foundry Co., Ltd., began in 1904. The high esteem in which he was held by the industry was shown by the large number who paid tribute by attending his funeral services, held from his residence at 53 Oakmount Road, Toronto, on July 14.

Mr. Millar is survived by his widow and one son, Rowland V. Millar, manager of Pease Heating Co., Ltd., to whom the Officers and Council of the Society express their sincere sympathy.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate to membership by letter ballot. During the past month 54 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by January 15, 1937, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALLCUT, E. A., Prof. Mech. Engrg., Univ. of Toronto, Toronto, Ont., Can.	Cyril Tasker H. H. Angus	A. J. Dickey M. W. Shears
BAKER, L. P., Air Cond. Engr., Canadian General Elec. Co., Ltd., Toronto, Ont., Can.	H. H. Angus M. S. Woollard	H. R. Roth O. E. Forrest (*Non-Member*)
BALLMAN, W. H., Chief Engr., Krich Rodisco, Newark, N. J.	H. W. Fiedler G. E. Olsen	F. B. Campbell J. A. Heller (*Non-Member*)
BENHAM, C. S. K., Sr. Draftsman, Benham & Sons, Ltd., London, W. 1., England	J. H. Walker G. N. Haden	Edgar Herring W. W. Nobbs
BERGAN, J. R., Sales Engr., Minneapolis-Honeywell Reg. Co., Detroit, Mich.	W. F. Arnoldy W. G. Boales	G. D. Winans F. J. Feely
BLACKMORE, J. J., Mfrs. Repr., Edwardsville, Ill.	E. A. White L. W. Moon	C. R. Davis G. W. F. Myers
BORNSTEIN, WILLIAM, Pres. & Gen. Mgr., Wm. Bornstein, Inc., Bethlehem, Pa.	Morris Sheffler C. B. Korn	T. H. Moyer (*A.S.C.E.*) J. H. Glanding (*A.S.C.E.*)
BROOKS, H. B., Sales Engr., Smith Distributing Co., Louisville, Ky.	A. R. MacMillan Albert Buenger	H. W. Moore J. C. Lewis (*Non-Member*)
BURNAM, C. M., JR., Engrg. Editor, Htg., Piping & Air Cond., Chicago, Ill.	S. I. Rottmayer J. H. Milliken	John Howatt J. R. Borling
CARNAHAN, J. H., Design Engr., Okla. Gas & Elec. Co., Oklahoma City, Okla.	S. L. Rolland E. W. Gray	Louin Tiller A. A. Hoppe
CRAWFORD, A. C., Sales Engr., Potomac Elec. Power Co., Washington, D. C.	S. L. Gregg W. E. Kingswell	H. R. Iverson F. M Thuney
CRIBARI, H. E., Sales Engr., American Radiator Co., New York, N. Y.	Jacob Kessler Jacob Miller	Philip Wolf Alfred Hering
CUNNINGHAM, J. S., Asst. Engr., The Rudy Furnace Co., Dowagiac, Mich.	A. P. Kratz W. H. Severns	S. Konzo M. K. Fahnestock
DAUBERT, L. L., Sales Engr., Airtemp Div., Sidles Co., Lincoln, Nebr.	Arledge Stokes M. J. Stevenson	I. C. Baker R. F. Rosenback (*Non-Member*)
DETERLING, W. C., Section Head, Industrial Dept., General Elec. Co., New York, N. Y.	C. S. Hoffman Arthur Ritter	F. R. Still W. H. Driscoll
DRIEMEYER, R. C., Asst. Chief Engr., Airtherm Mfg. Co., St. Louis, Mo.	L. B. Scherrer E. E. Carlson	R. J. Tenkonohy F. A. Berger (*A.S.M.E.*)
EVANS, B. L., Design & Installation, Langenberg Htg. Co., St. Louis, Mo.	E. B. Langenberg L. W. Moon	A. P. Kratz S. Konzo

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
FAIRBANKS, F. L., Prof. Agric. Engrg., Cornell Univ., Ithaca, N. Y.	W. H. Elwood W. M. Sawdon	J. W. Williams E. H. Woods
FAXON, H. C., Engr., Appliance Section, The Borneo Co., Ltd., Singapore, S. S.	Docter Carter C. B. Morrison	H. W. Hart-Baker A. W. Turner (*Non-Member*)
FORRESTER, C. M., Air Cond. Engr., The Gurney Fdry. Co., Toronto, Ont., Can.	G. T. Wilson D. I. Paul	J. H. Fox W. D. Gordon
GANGE, F. B., Managing Director, Gordon & Co., Ltd., Shanghai, China	H. L. Alt C. F. Hauss	A. V. Hutchinson Jack Cowell (*Non-Member*)
GENDRON, HENRI, Air Cond. Sales Supervisor, Canadian Gen. Elec. Co., Montreal, Que., Can.	F. R. Barnsley G. L. Wiggs	A. B. Darling C. W. Johnson
HANSON, L. P., Design Engr., U. S. Air Cond. Corp., Minneapolis, Minn. (*Advancement*)	A. E. Bauer J. R. Hall	C. F. Hawkinson B. P. Edelman
HEDDEN, W. M., Treas., The Hedden Co., Dover, N. J.	O. O. Oaks R. C. Cook (*Non-Member*)	L. R. Jacobus (*Non-Member*) J. D. Thomas (*Non-Member*)
HEWETT, J. B., Engrg. Mgr., Hudson Air Cond. Corp., Washington, D. C. (*Advancement*)	W. E. Kingswell W. A. Danielson	M. D. Kiczales T. H. Urdahl
HOBBIE, E. H., Sales Promotion, Mississippi Glass, New York, N. Y.	W. C. Randall A. N. Finn (*Non-Member*)	R. A. Miller G. B. Watkins (*Non-Member*)
JONES, J. P., Consulting Engr., John Paul Jones, Cary & Millar, Inc., Cleveland, Ohio	E. B. Cary L. T. Avery	R. A. Wilson W. E. Stark
KAERCHER, C. M. H., Managing Director, Central Bureau for Htg. & Air Cond., Cleveland, Ohio	R. A. Wilson L. T. Avery	F. A. Rodgers W. R. Beach
KESSLER, M. E., Mgr., Pioneer Elec. Co., Niagara Falls, N. Y.	S. W. Strouse B. C. Candee	D. J. Mahoney M. C. Beman
KNUDSEN, W. R., Mgr. Air Cond. Div., Frigidaire Corp., Chicago, Ill.	J. R. Vernon Tom Brown	J. A. Cutler J. J. Philippi (*Non-Member*)
LA ROCQUE, P. E., Htg. Contractor, Quebec, Que., Can.	G. L. Wiggs A. B. Darling	T. E. McGrail C. W. Johnson
LEWIS, C. A., Draftsman, J. C. Penney Co., New York, N. Y.	E. A. Bennett Arthur Ritter	F. R. Still R. R. Ferguson
MAHER, T. F., JR., Boiler Salesman, Thomas F. Maher, Jr., St. Albans, L. I., N. Y.	G. E. Olsen L. W. Charlet	W. R. Fidelius B. H. Schulze
MARSTON, A. D., Air Cond. Engr., Kansas City Power & Light Co., Kansas City, Mo.	A. L. Maillard David Caleb	C. A. Flarsheim L. R. Chase
MARZOLF, F. X., Sales Engineer, Minneapolis-Honeywell Reg. Co., Detroit, Mich.	W. F. Arnoldy W. G. Boales	G. D. Winans F. J. Feely
MASON, G. C., Sales Engr., Williamson Heater Co., Cincinnati, Ohio	T. W. Torr D. B. Poling	E. C. Thompson (*Non-Member*) P. S. Miller (*Non-Member*)
MAYER, R. W., Dist., Mgr., Minneapolis-Honeywell Reg. Co., Cincinnati, Ohio	K. W. Schick E. B. Royer	W. C. Pistler G. B. Houliston
MCCAIN, H. K., Sales Engr., G. M. Sales Corp. (Frigidaire Div.), Atlanta, Ga.	E. E. Bocock (*Non-Member*) E. F. Yancey (*Non-Member*)	S. W. Boyd (*A.I.E.E.*) P. R. Yopp (*Non-Member*)
METCALFE, CURTIS, Engr. (House Htg. Dept.), Detroit City Gas Co., Detroit, Mich.	J. P. Schechter W. G. Boales	G. D. Winans F. J. Feely
MORIARTY, J. M., Owner, Consolidated Htg. & Vtg. Co., Los Angeles, Calif.	O. W. Ott W. E. Barnum, Jr.	H. M. Hendrickson N. W. Berglund
MOLONEY, R. R., Asst. Engr. Supt., E. D. Sassoon & Co., Shanghai, China	H. W. Hart-Baker C. J. Doughty	I. K. Kwan P. Y. Loo
PEART, A. M., Sales Engr., Minneapolis-Honeywell Reg. Co., Montreal, Que., Can.	G. L. Wiggs F. R. Barnsley	G. H. Osborne C. W. Johnson
PINTO, C. B., Div. Head, Plbg. & Htg., Montgomery Ward & Co., Jamaica, L. I., N. Y.	J. F. Brocha H. A. Maccubbin	J. H. Seippel (*Non-Member*) E. J. Ilg (*Non-Member*)
REIF, A. F., Pres., Reif-Rexoil, Inc., Buffalo, N. Y.	C. H. Graham T. I. Messenger	P. S. Hedley J. J. Yager
REIF, C. A., Vice Pres., Reif-Rexoil, Inc., Buffalo, N. Y.	C. H. Graham T. I. Messenger	P. S. Hedley J. J. Yager
ROSENTHAL, EMANUEL, Student, New York Univ., New York, N. Y.	H. L. Hosking E. J. Ritchie	R. W. Cumming J. W. Kingsbury (*Non-Member*)
SCHLEMMER, B. G., Student, Purdue Univ., West Lafayette, Ind.	J. D. Hoffman H. L. Solberg (*Non-Member*)	W. T. Miller (*Non-Member*) L. V. Ludy (*Non-Member*)
SCHULZ, E. L., Asst. Commercial Engr., Consolidated Edison Co., Flushing, N. Y.	W. R. Zuhlke J. R. Denise	M. C. Giannini A. A. Adler
SLEMMONS, J. D., Br. Mgr., American Blower Corp., Columbus, Ohio	A. I. Brown D. B. Poling	A. J. Nesbitt F. R. Still

CANDIDATES

SMITH, W. O., Owner, Smith Automatic Heat Service Co., Detroit, Mich.

THOM, G. B., Asst. Prof. Mech. Engrg., Swarthmore College, Swarthmore, Pa.

WILSON, H. B., Sales Engr., Brooklyn Union Gas Co., Brooklyn, N. Y.

WORTHINGTON, T. H., Br. Mgr., Dom. Radiator & Boiler Co., Ltd., Montreal, Que., Can.

WORTON, WILLIAM, Br. Mgr., C. A. Dunham Co., Ltd., Winnipeg, Man., Can.

REFERENCES

Proposers	*Seconders*
W. G. Boales A. H. Kirkpatrick	G. D. Winans F. J. Feely
M. C. Stuart F. V. Larkin (*A.S.M.E.*)	B. H. Jennings (*A.S.M.E.*) S. B. Lilly (*Non-Member*)
John James J. J. Deely	F. B. Herty H. E. Birkett (*Non-Member*)
H. B. Jenney W. R. Blackhall	A. J. Dickey M. W. Shears
C. H. Turland William Glass	Frank Thompson J. B. Steele

Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BARTON, JAY, Gen. Mgr. (Mfg. Div.), Nelson Co., Detroit, Mich.

BEARMAN, A. A., Engr. in Charge of Air Cond. Plant, 20th Century-Fox Film Corp., New York, N. Y

HALLER, A. L., Pres., Haller App. Sales Co., Inc., St. Louis, Mo. (*Reinstatement*).

HESS, A. J., Design Engr., E. L. Ellingwood, Los Angeles, Calif.

IVERSON, H. R., Br. Engr. & Salesman, The Trane Co., Washington, D. C. (*Advancement*)

JENNINGS, H. K., Sales Engr., Avery Engrg. Co., Cleveland, Ohio.

KILPATRICK, W. S., W. S. Kilpatrick & Co., Los Angeles, Calif. (*Reinstatement*)

KONZO, SEICHI, Special Research Assoc., Univ. of Ill., Urbana, Ill. (*Advancement*)

MCCREA, J. B., Htg. & Vtg. Engr., Detroit, Mich.

MURDOCH, J. P., JR., Pres., John P. Murdoch Co., Philadelphia, Pa.

PAINTER, D. H., Mfrs. Repr., Hoffman Specialty Co., Kansas City, Mo. (*Reinstatement and Advancement*)

PERRAS, G. E., Htg. Expert, Thos. Robertson & Co., Ltd., Montreal, Que., Can.

SNAVELY, A. B., Chief Engr., Hershey Chocolate Corp., Hershey, Pa.

TAYLOR, H. J., Htg. Contractor, Detroit, Mich.

TIMMINS, W. W., Dist. Mgr., Canadian Powers Reg. Co., Ltd., Montreal, Que., Can.

VJESSMAN, WARREN, Design Engr., U. S. Treas. Dept., Washington, D. C. (*Reinstatement*)

WAGNER, E. A., Pres., Wagner Engrg. Corp., Pittsfield, Mass. (*Advancement*)

WARE, J. H., 3RD, Vice Pres., City Gas & Fuel Co., Oxford, Pa.

ASSOCIATES

BROWN, WILLIAM, Vice Pres., The Carey Co., Detroit, Mich.

DEANE, J. H., Sales Engr., Detroit Lubricator Co., Chicago, Ill.

DEPPMANN, R. L., Mgr., R. L. Deppmann Co., Detroit, Mich.

DIXON, M. F., Combustion Engr., Imperial Oil, Ltd., Montreal, Que., Can.

DOLSON, C. N., Sales Engr., R. F. Knoche & Son, Hamburg, N. Y.

FORD, E. F., Sales Repr., American Radiator Co., Detroit, Mich.

FREDERICK, W. L., Pres., Bryant Air Cond. Corp., Washington, D. C.

GITTERMAN, HENRY, Dist. Repr., Independent Air Filter Co., New York, N. Y.

KEYSER, H. M., Sales Engr., Murray W. Sales & Co., Detroit, Mich.

KING, H. K., Dist. Mgr., Tube-Turns, Inc., Louisville, Ky.

HAMAKER, A. C., Mgr. Home Htg. Dept., The J. L. Hudson Co., Detroit, Mich.

HYDE, E. H., Tech. Repr., Koppers Co., Pittsburgh, Pa.

LONG, D. J., Sales Engr., W. G. Boales Co., Detroit, Mich.

NOBLE, J. P., Dist. Engr., Air Cond. Dept., Frigidaire Corp., Dayton, Ohio.

ROSS, J. D., Sales Engr., Ry. & Engrg. Specialities Ltd., Montreal, Que., Can.

SHAW, C. G., Engrg. Design, Brazelton Lumber Co., Waco, Texas.

SPARKS, J. D., Repr., Ilg Elec. Vtg. Co., Seattle, Wash.

STEHL, H. V., Sales Engr., Campbell Metal Window Corp., Baltimore, Md.

WAECHTER, H. P., Supt. of Air Cond., W. T. Grant Co., Staten Island, N. Y. (*Reinstatement*)

YOUNG, H. J., Sales Engr., Young Radiator Co., Muskegon, Mich.

ZWALLY, A. L., Air Cond. Engr., Interstate Elec. Co., Shreveport, La.

JUNIORS

BEECHLER, J. S., Air Cond. Engr., Kelvinator Corp., Detroit, Mich.

BIANCULLI, V. A., Draftsman, S. A. S. Patorno, New York, N. Y.

CHEATWOOD, W. H., Installation Engr., Interstate Elec. Co., Shreveport, La.

COX, T. M., JR., Sales Engr., Neal & Massy Engrg. Co., Ltd., Port of Spain, Trinidad, B. W. I.

FEINBERG, EMANUEL, Sales Engr., Ilg Elec. & Vtg. Co., Detroit, Mich.

GURNEY, E. R., Asst. Engr., Gurney Fdry. Co., Toronto, Ont., Can.

JELINEK, F. R., Sales Engr., Johnson Service Co., Detroit, Mich.

LOUGHRAN, P. H., JR., Cadet Engr., Washington Gas Light Co., Washington, D. C.

PAQUET, J. M., Design Engr., J. A. Y. Bouchard, Ltd., Quebec, Que., Can.

WHITT, S. A., Air Cond. Engr., Kelvinator Corp., Detroit, Mich.

WOOD, R. A., Editorial Asst., Fueloil Journal, New York, N. Y.

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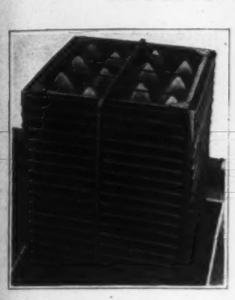
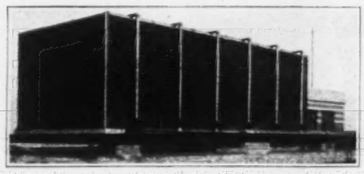
WINDSOR, ONTARIO, CANADA

REPRESENTATIVES IN PRINCIPAL CITIES

COOLING TOWERS—SPRAY NOZZLES—COOLING PONDS—SPRAY PAINTING EQUIPMENT





"Binks" Atmospheric Spray Cooling Towers

"Binks" Atmospheric Spray Cooling Towers are made in a wide range of sizes to handle capacities from 5 to 1200 g.p.m. They are used and recommended for all types of industrial water cooling work and are suitable in the standard sizes for refrigeration plants ranging from 2 to 240 tons and for Diesel engine plants ranging from 30 to 3600 hp.

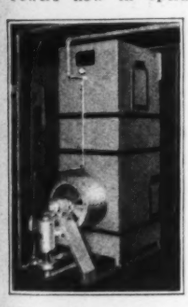
The towers consist of a heavy shop welded copper-bearing steel frame, genuine wrought iron manifold with welded feeder arms and bronze nozzles. All metal parts are hot dip galvanized after fabrication.

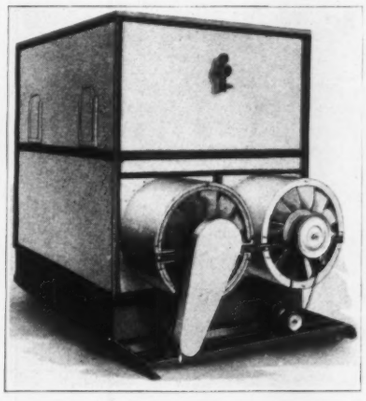
Louvres consist of clear all heart redwood or galvanized steel, to suit requirements.

Due to standardized construction features "Binks" Atmospheric Spray Towers may be quickly erected on the job, for either ground or roof installation from a simple elevation print furnished with each unit, without skilled factory supervision.

All bolts and nuts for assembling are cadmium plated, louvres being inserted to the tower frame in slip fit louvre retainer channels requiring the use of no bolts, nuts or any other fastening.

There are more than 2000 "Binks" Atmospheric Towers now in operation.





"Binks" Indoor Forced Draft Cooling Towers

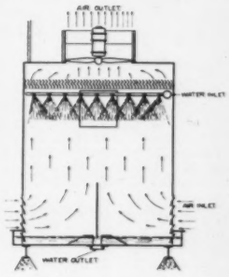
"Binks" Indoor Forced Draft Cooling Towers are made in standard sizes from 5 g.p.m. up to and including 300 g.p.m. They are extensively used for the cooling of jacket water for Diesel engines and large capacity air compressors, for condensing water for refrigeration machines and various industrial processes.

This type of equipment is exceptionally well adapted in locations where outdoor mounting of towers on building roofs would be extremely costly due to piping the installation to and from the tower. These units may be conveniently placed adjacent to the process with provision being made for fresh air inlet to the tower, such as open doors or windows, whereas the saturated air is conveyed to the outdoors through a duct.

Towers are constructed entirely of heavy gauge galvanized steel with ¼-in. boiler plate pans fitted complete with automatic float valve, overflow and drain connection and are furnished complete with or without circulating pump, as desired.

Fans are cast aluminum, blades being cast integral with the hub, and are extremely quiet in operation.

Write for Complete Catalog and Prices on any "Binks" Equipment in which you are interested.

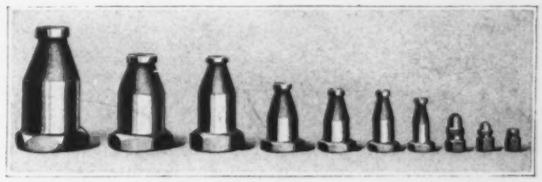


"Binks" Type "K" Induced Draft Towers

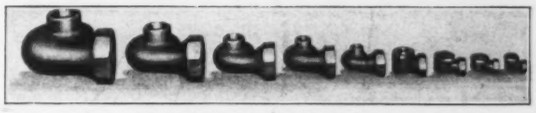
The "Binks" Type "K" Induced Draft Towers are designed for outdoor mounting either on ground or building roofs and are made in sizes from 25 to 800 g.p.m. capacity. They are extensively used for all industrial water cooling requirements and standard sizes are suitable for refrigeration work ranging from 6 to 200 tons and for Diesel engine service from 90 to 3000 hp.

Fan assemblies are mounted to top of tower directly connected to geared head motors which are splash, moisture and weatherproof. Capacities of fans from 3200 to 96,000 c.f.m., depending on tower size, and are extremely quiet in operation, drawing air upward through tower from open louvre sections at bottom. This principle of mechanical draft tower construction eliminates wind noises in the casing and is representative of one of the most efficient mechanical draft towers made. They are constructed entirely of galvanized steel of heavy gauge, complete with ¼-in. pans, and are shipped knocked down with complete assembly drawings for field installation which can be accomplished by ordinary labor.

"S" P R A - R I T E



"R" O T O J E T



"Binks" Spray Nozzles
Made in all types for every cooling and industrial need

Spray Painting Equipment

This company has been a leader in spray finishing equipment since 1893.

Spray guns of all types.

Compressed air supply systems.

Compressed air cleaning systems.

Spray booths and exhaust systems.

Water wash spray booths; for reclaiming porcelain enamel; also for synthetic enamel and other materials.

Paint supply systems: individual pressure tanks or pipe line circulating systems.

Conveyor systems for handling items to be sprayed.

Complete accessory equipment for the finishing department.

"Binks" Thor Model 7 Spray Gun
Price $30.00

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In Tannate Belts pliability, strength, grip and durability **are combined** in an unusual degree.

EFFICIENCY AND ECONOMY

For Industrial use we know of no short-center drive that under hard service has given better results than a Rockwood Drive equipped with a Rhoads Tannate Belt.

The efficiency of this equipment under full load is 98% or better. The first cost is usually less than V-Rubber Belts or Chain drives. It is a trouble saver.

CLIENTS TESTIFY THAT IT HAS ELIMINATED TROUBLE AND INCREASED EFFICIENCY FOR THEM. We furnish this equipment complete (Tannate Belt and Base), and shall be glad to give engineering aid about installation. USE THIS FOR FAN DRIVES.

SAVE BY MODERN GROUP DRIVES

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Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 202.

New Conduit for Underground Lines

No. 1143—A new type of tile conduit ("Adsco-Bannon") for underground steam and hot water lines is simple in design and is easily installed at low labor cost, according to the manufacturer. It consists of a base drain tile supporting a circular, salt glazed, vitrified tile conduit. The conduit, with bell and spigot joints in approximately 2 ft lengths, is separable on the job into two halves along the horizontal center line with a resulting diagonal fracture. The bottom half of the conduit is placed on the base drain, the joints mortared and the trench backfilled to approximately the top of the half section of conduit. Pipe rollers or multiple pipe supports with rollers are placed in recesses in the two horizontal, reinforcing ribs which are in the bottom of the pipe support sections of conduit. The pipe supports are held rigid without piercing the conduit wall.

One or more pipes can be installed, tested, inspected and insulated with standard insulations before the top half of the conduit is placed. The top and bottom halves of the conduit are sealed with mortar in the bell and spigot joints and between the projecting outside lips on each side of the conduit, then the trench is ready for backfill.

Available in various sizes to accommodate one or more pipes, with or without insulation. Sectional asbestos or any one of several filler types of insulation, such as rock wool, can be used in the conduit.—American District Steam Co., North Tonawanda, N. Y.

Small Capacity Unit Heaters

No. 1144—New small size unit heater having a capacity of 75 E.D.R. is of handsome appearance and is quiet in operation for use in game rooms, small offices, gasoline stations and other similar size installations.

Heating element is made up of streamline tubes with individual convoluted fins. Element is mounted in cabinet by means of full-floating mountings which eliminate expansion stresses between element and cabinet, and at the same time maintain alignment of element with full protection against piping strains, according to the maker.—Fedders Mfg. Co., 57 Tonawanda St., Buffalo, N. Y.

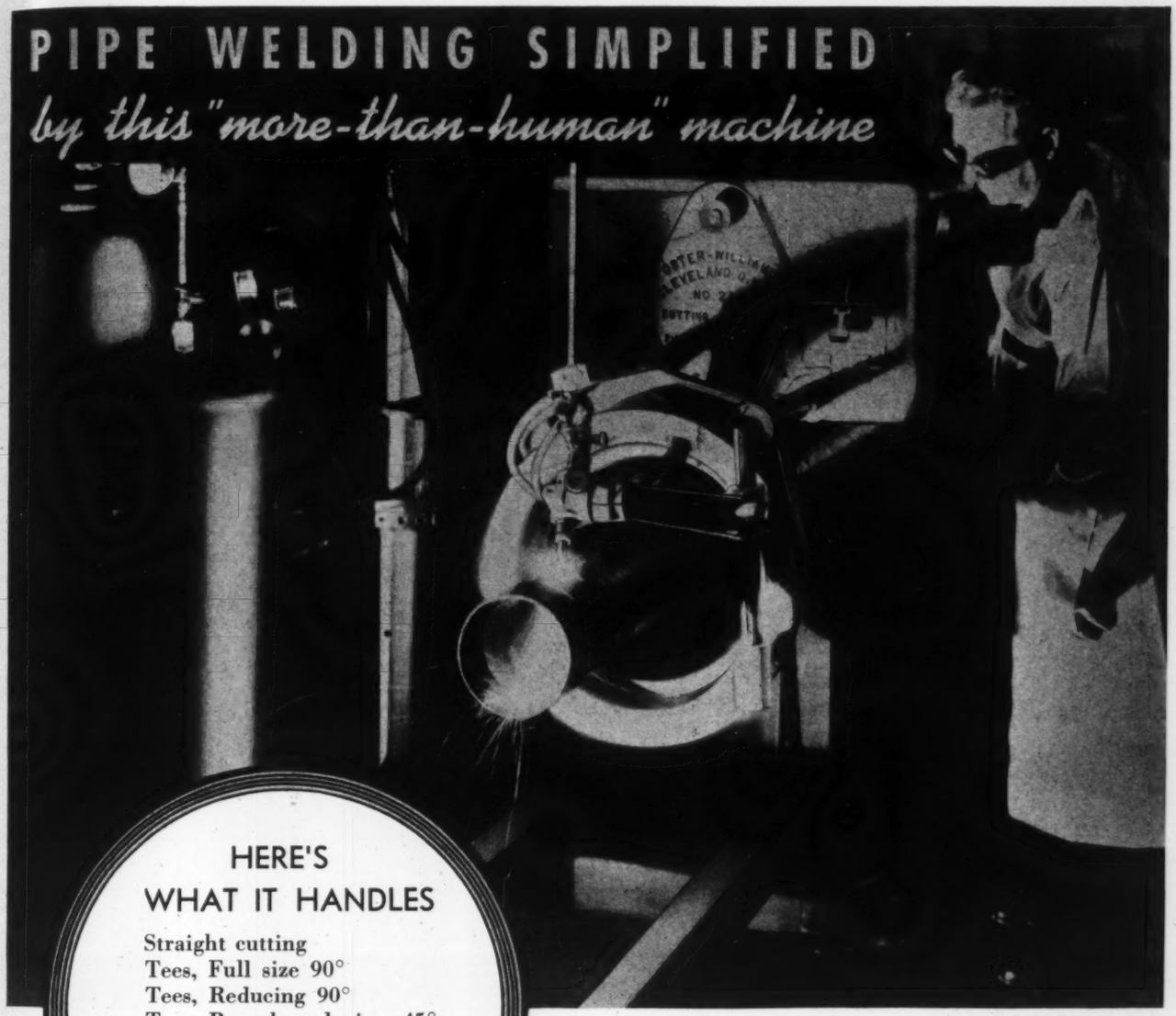
New Temperature Control Line

No. 1145—A new line of temperature controls for industrial and domestic applications has been placed on the market.

All types incorporate the same principle of operation—a bimetallic element which actuates a mercury switch. This mercury switch is unbreakable, the case being of metal instead of glass and completely sheathed in molded bakelite. The new features of design assure a useful

PIPE WELDING SIMPLIFIED

by this "more-than-human" machine



HERE'S WHAT IT HANDLES

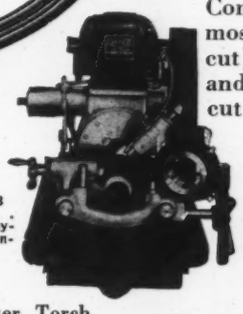
Straight cutting
Tees, Full size 90°
Tees, Reducing 90°
Tees, Branch reducing 45° to 90°
Elbows
Miters
Hole cutting
Capacity, 2½-in. to 12-in.

WITHOUT TEMPLATES . . . WITHOUT CAMS WITHOUT LAYING OUT THE JOB IN ADVANCE

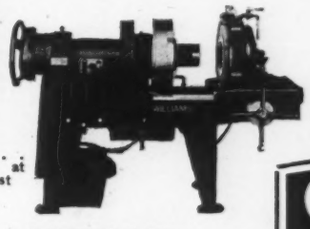
By installing an Oster Torch Cutter any shop which handles a considerable amount of pipe welding will show a quick and easy profit on work that requires exceptional skill when performed by hand.

Completely automatic . . . . (five simple settings are the most that are required for even the most complicated cut) . . . . Oster No 212 eliminates all chance of mis-cuts and of intersections that do not match perfectly. Every cut is beveled perfectly for welding with an edge so smooth that it has the appearance of a job done with a lathe tool.

BULL DOG DIE-STOCK . . . . world-popular for its 5 Big Features



TOM THUMB PORTABLE . . . . a money-maker for contractors



WILCO . . . . big output at low first cost

Send for complete description of the Oster Torch Cutter, a simple-to-operate mechanical marvel which will increase your pipe-welding output, improve its quality and lower your costs.

THE OSTER MANUFACTURING COMPANY

Sales Offices: 2068 East 61st Street, Cleveland, Ohio
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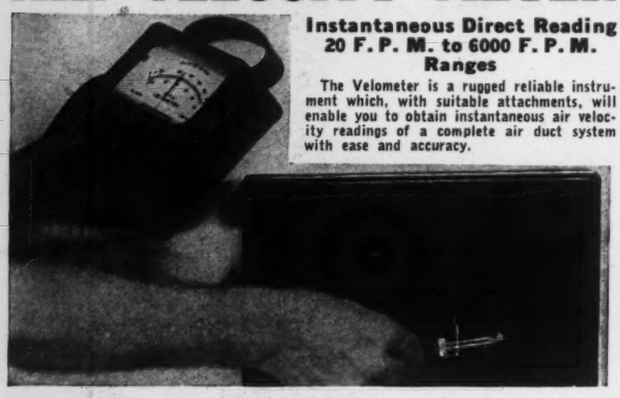
THREADING HEADQUARTERS SINCE 1893

OSTER THREADING EQUIPMENT WILLIAMS

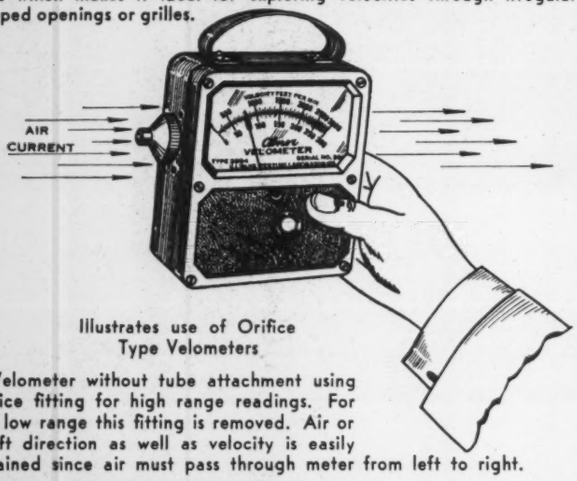
AN ALL PURPOSE AIR VELOCITY METER



Instantaneous Direct Reading 20 F. P. M. to 6000 F. P. M. Ranges

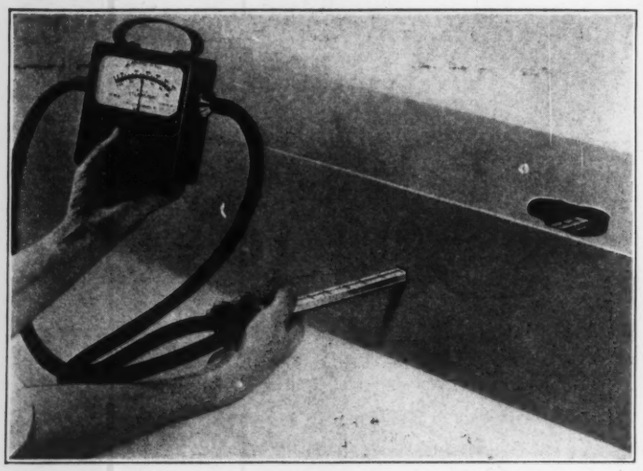
The Velometer is a rugged reliable instrument which, with suitable attachments, will enable you to obtain instantaneous air velocity readings of a complete air duct system with ease and accuracy.

Velometer with Type 2220 jet. This gives spot air velocity readings which makes it ideal for exploring velocities through irregular shaped openings or grilles.



Illustrates use of Orifice Type Velometers

Velometer without tube attachment using orifice fitting for high range readings. For the low range this fitting is removed. Air or draft direction as well as velocity is easily obtained since air must pass through meter from left to right.



This illustration shows the Velometer as used to ascertain air velocities inside of ducts. With the aid of the Type 2425 Duct Jet the reading is easily obtained and is directly indicated in feet per minute on the scale. No charts or calculations are necessary.

TYPE 2215

Used generally in commercial work at register or grille face for obtaining quick average velocity readings over a 4½" area.

TYPE 2480

This jet is used to obtain direct readings of static pressure of duct, plenum chambers, or pipes in "Inches of Water".

Write for complete bulletin.

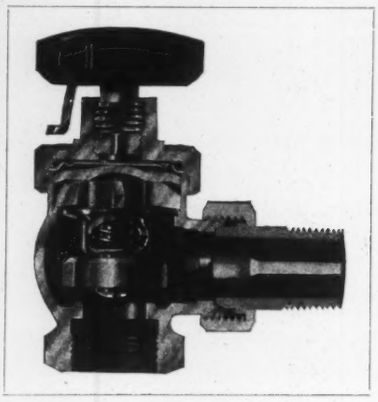
ILLINOIS TESTING LABORATORIES, Inc. 419 N. La Salle Street CHICAGO, ILLINOIS

life of many millions of operations with constantly uniform regulations and extreme accuracy on close operating differentials, says the maker.

The air switch illustrated is designed for applications requiring remote control of the heating plant and regulation of the plant by room temperature, or the temperature of any body of gas. Range of adjustment is 25 to 85 F. Dimensions, 5x3x2¾ in.—Jefferson Electric Co., 25th & Madison St., Bellwood, Ill.

Packless Valve Eliminates Bellows

No. 1146—Designed for service with convection heaters, radiators or other equipment used on two pipe vapor, vacuum or steam systems, new "Hermetic" radiator valve is a durable device that eliminates the necessity of a bellows. It has no gaskets, stuffing boxes or packing. The valve proper receives its motion through a sealed diaphragm from a pressure button on the end of the valve stem. Movement of this diaphragm does not exceed 3/32 in., at any time, which small range of movement assures long diaphragm life, says the maker.



Body is of cast brass with forged brass bonnets and collars. Heavy nickel plating with polished trim is applied to all exposed metal parts. A composition disc closes tightly against a flat raised seat.

The standard pattern is provided with a wheel handle of non-heating bakelite which is impervious to water. Others are available in key operated lock and shield pattern, lever handle or wheel and chain type for ceiling installations. In the wheel handle pattern, valve is available with or without a nickeled indicator.—Trane Co., La Crosse, Wis.

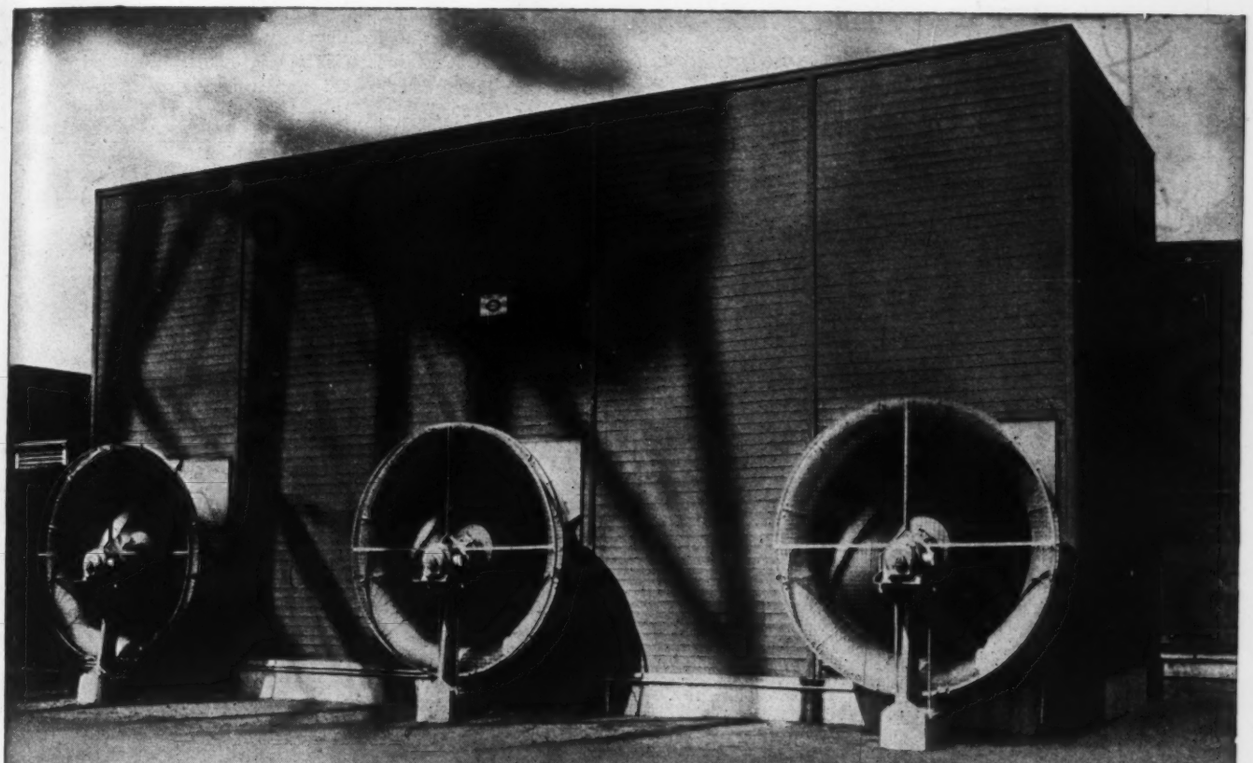
Ozone Unit for Duct Installation

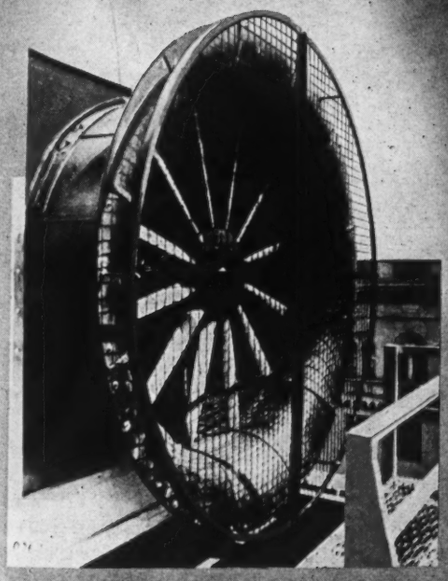
No. 1147—An ozone unit has been developed for attachment to individual heating, ventilating or air conditioning ducts. It can be attached to any air duct, and thus ozonate the air going into a single room or section of a building. Air enters at the right end of the unit, is ozonated as it passes through, and is discharged into the duct at the left for distribution. As on central plant and portable models, unit is equipped with a rheostat and meter for regulated ozone generation.

The unit makes possible a permanent installation for ozonating air in ducts serving only a part of a building, where heretofore nothing could be used except portable models. Manufactured in three sizes having capacities of 3,000, 4,000 or 5,000 cfm.—Electroaire Corp., 1455-57 W. Congress St., Chicago, Ill.

Announces Electric Temperature Controls

No. 1148—Sarco Co., Inc., manufacturers of steam specialities, has announced the completion of a new line of electric temperature controls for heating, air conditioning, refrigeration, and industrial processes. These developments are based on patents and designs acquired from Wilbin Instrument Corp., which company has been liquidated.





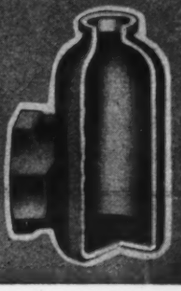
Let Us Spray
COOLING MARLEY EQUIPMENT
"THE BETTER WAY"

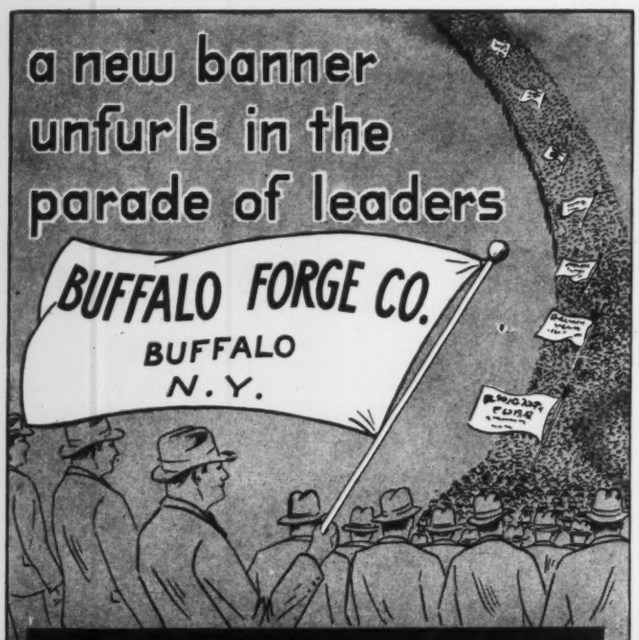
The Marley policy of continuous research and constant improvement provides advanced designs in water cooling equipment; assures a consistently better service and product to meet rapidly growing water cooling requirements.

For efficiency—for economy—for reliability—install a Marley water cooling system.

THE MARLEY COMPANY
1915 WALNUT KANSAS CITY, MO.

MARLEY
WATER COOLING SYSTEMS





ANOTHER PROMINENT MANUFACTURER
HAS BEEN LICENSED BY
AUDITORIUM

All interested in real air conditioning will be glad to know that BUFFALO FORGE COMPANY, Buffalo, N. Y., one of the oldest and best known manufacturers of heating and ventilating equipment, has signed agreements with Auditorium Conditioning Corporation whereby it has recognized the validity of its Patents and may install Central Station Air Conditioning Systems, or give permission to others to do so. It also has the right to manufacture and sell Unit Conditioners utilizing these same patents.

THE ROLL

American Blower Corporation
Detroit, Michigan

Buffalo Forge Company
Buffalo, New York

Carrier Corporation
Newark, New Jersey

Frick Company
Waynesboro, Pa.

General Electric Company
Schenectady, New York

J. O. Ross Engineering Corporation
New York, N. Y.

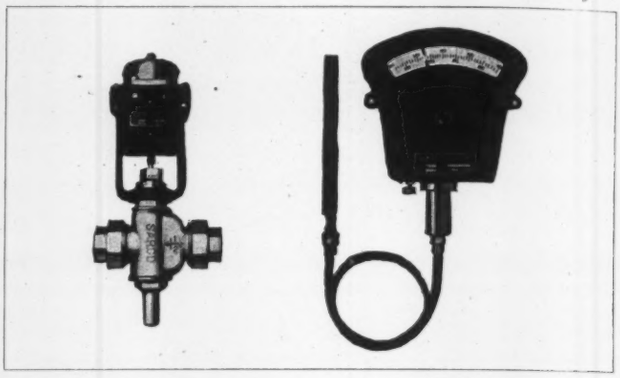
The Cooling & Air Conditioning Corporation
(Division of B. F. Sturtevant Co.)
Hyde Park, Boston, Mass.

York Ice Machinery Corporation
York, Pa.

All of the Licensees named may install Licensed Systems, or extend permission to others to do so. They have branch offices in many cities where a bound volume of Auditorium Patents is available for reference.

AUDITORIUM CONDITIONING CORPORATION
New York Office—17 East 42nd Street . New York

The controls include line voltage thermostats, ranging from simple room types to multiple switch dial thermometer thermostats for exacting industrial requirements. Included also are hydraulically operated motor valves for steam, gas, oil, water, brine, or "Freon."



A thermostat and one of the motor valves are shown.—Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

New Industrial Building Design Facilitates Air Conditioning

No. 1149—A new design for single story industrial buildings, providing broader factory aisles, unobstructed head room to full ceiling height, and maximum uniform daylight throughout, has been developed through the use of welded rigid frame construction. With all non-functional members eliminated, the design will give unobstructed space for ventilating or air conditioning ducts, pipes, and other functional equipment, it is said.

Entirely stripped of cross members and trusses which cast spider web shadows across most factory areas today, the design embodies a continuous rigid saw tooth frame formed by the welding of rolled beam sections which permit economical construction of aisles up to 50 ft in width. It is particularly adaptable to requirements of machine shops, precision parts production, and the textile, food and printing industries, where air conditioning is a factor of increased importance.—Austin Co., Cleveland, Ohio.

Current Saving Motor Control for Welders

No. 1150—New "current saving" arc welders embody what is termed by the manufacturer as selective motor hp control for economical control of the motor as well as the generator. Advantages are said to be that only ⅓ the usual starting current is required, power factor and efficiency are materially improved, and it is possible to use the equivalent of a motor of ½ the hp rating for welding in ranges up to ½ and ⅔ the rated capacity of the generator.

Operation of the selective motor control is simple, states the

MIDWEST WELDING ELLS are Stress Relieved

This operation is characteristic of the care given every detail in the manufacture of Midwest Welding Ells . . . care that is reflected in a growing preference for Midwest Fittings among designers, construction engineers and welders who are concerned with welded piping.

The Midwest Welding Ell is formed from one piece of rolled steel plate by a special process developed and patented by Midwest. The longitudinal seam along the inner circumference is made with a high tensile strength alloy rod. At this stage, the fitting is slightly oversize.

The Midwest Ell is then reheated and reduced to accurate size and shape by a final working of the metal in COMPRESSION at a forging heat. Normalizing both the plate and the weld relieves the stresses set up in the forming and welding operations. Comparative corrosion tests as well as tensile and ductility tests have proved the beneficial effect of this process.

Bulletin WF-36 explains the many other features of Midwest Welding Fittings. Ask the nearest office (or distributor) for a copy.

MIDWEST PIPING & SUPPLY COMPANY, Inc. *Main Office:* 1450 South Second St., St. Louis, Mo.

PLANTS: St. Louis, Passaic (N. J.) and Los Angeles • SALES OFFICES: Chicago—946 Marquette Bldg. • Houston—1716 Second Nat. Bank Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Bldg.

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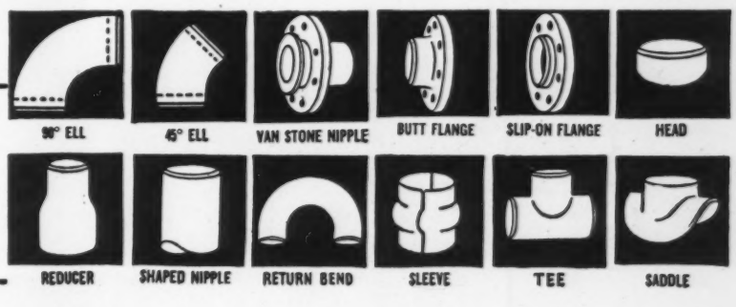
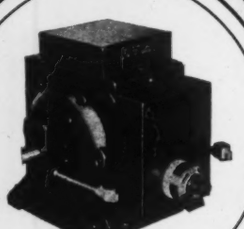
WELDING FITTINGS
IMPROVE PIPING DESIGN AND
REDUCE COSTS

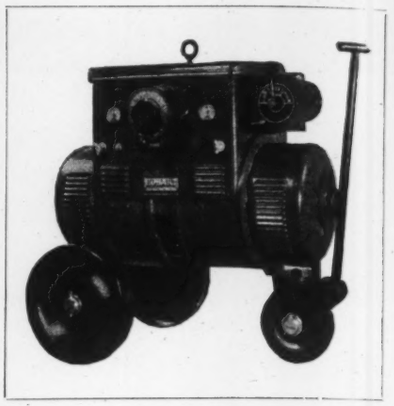


Holtzer Cabot
MOTORS
are built Quiet
and
stay Quiet



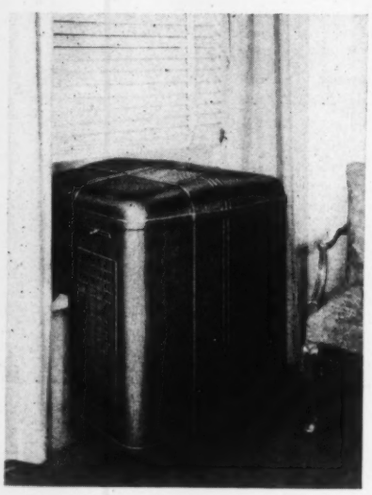
WILL·GIVE·LONG
QUIET·SERVICE
·· FREE·FROM·TROUBLE
Let us help solve
your Motor Problem
THE HOLTZER-CABOT
ELECTRIC COMPANY
Boston, Mass.
MOTOR SPECIALISTS.

maker. A latch locks the handle in the "low" position where only half the rated motor hp is used for starting and for welding up to ½ the rated generator capacity in continuous manual arc welding (up to ⅔ rated capacity for intermittent welding). When desired to operate at higher rates, a lever releases the handle for turning to the "high" position where the full rated hp of the motor is available for full load and overload welding.



The welders are available in 75 amperes, 1½ to 3 hp; 100 amperes, 2½ to 5 hp; 150 amperes, 5 to 10 hp; 200 amperes, 7½ to 15 hp; 300 amperes, 10 to 20 hp; 400 amperes, 12½ to 25 hp; and 600 amperes, 20 to 40 hp.—Hobart Bros., Troy, Ohio.

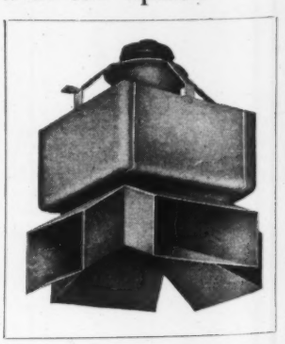
Room Cooler Easily Installed



No. 1151—New window mounted room cooler embodies ease and quickness of installation and inexpensive operation costs, reports the maker, who states that it can be installed in less than 25 minutes. It is necessary only to open the window of the room about half way, rest the unit on the sill, place the cabinet in position, and plug the cord into a wall socket.

Features include an hermetically sealed unit, built-in "Watchman" to guard motor against overheating; a compressor and motor cooled by refrigerant lines around the shell; a powerful oil pump that insures adequate and continuous lubrication; air filters to insure clean air; ventilating damper that permits exhaust of foul air from the room; and an efficient means of insulation that deadens noise, making for quiet operation.—Westinghouse Electric & Mfg. Co., Mansfield, Ohio.

Vertical Unit Heater for Wide Air Spread



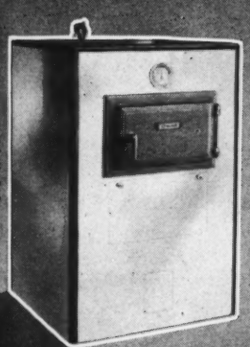
No. 1152—A quiet operating vertical type unit heater just announced is designed for applications in factories, garages, and similar installations where heated air is to be spread over large areas. Unit is available in 28 sizes and with four diffuser arrangements.

It is equipped with "cradle coil" feature to eliminate expansion and contraction strains on the heating element, which is allowed to expand and contract freely in the casing with the coil resting on a spring instead of being connected directly.—Trane Co., La Crosse, Wis.

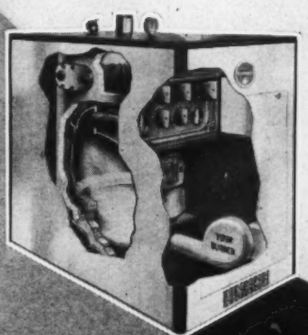
n NEW Smartline Jackets

Whether selling boots or boats or boilers, *appearance alone often makes or breaks a sale.* With these new jackets . . . trim as the "Zephyr" or a streamlined motor car, and requiring no extra floor space . . . Kewanee Boilers have been given that added eye appeal which speeds up sales.

The SQUARE REGAL Smartline — to completely enclose the boiler and any short burner



The REGAL Smartline — to completely enclose the boiler and any long burner



But proud as any maker might well be of these new jackets, we still say: **"It's what's under the jacket that counts."** And under each of them is a healthy heart of steel . . . the sturdy Kewanee "R" which has established such enviable records for economically heating homes and smaller buildings.

The Round "R" Line has been enlarged to include boilers as small as 400 sq. ft.

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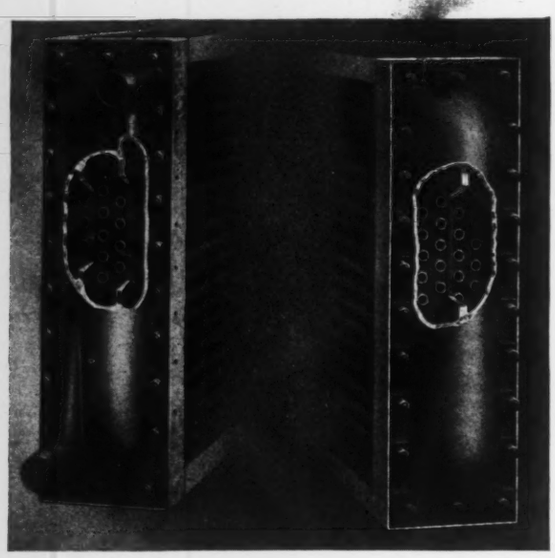
AEROFIN
With Removable Headers Simplifies Cleaning of Tube Interior



LEFT: Water connection end of unit showing baffles for 18-tube single pass. For 36 tubes double pass, center baffles only used. RIGHT: Rear end for 18-tube single pass. For 36 tubes double pass, baffle omitted.

Aerofin Cleanable Tube units, for heating and cooling with water, have been designed for use where the prevalence of sediment or scale-forming chemicals in the water, makes periodic cleaning necessary.

Now, by the simple removal of a few bolts, both end headers may be disengaged, exposing the ends of all tubes.

Headers are designed so that water may be circulated in single or double passes (18 or 36 tubes in parallel) making possible the use of large quantities of water with small head loss. Send for descriptive folder.

AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus.

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Newark NJ
Chicago Detroit New York Philadelphia

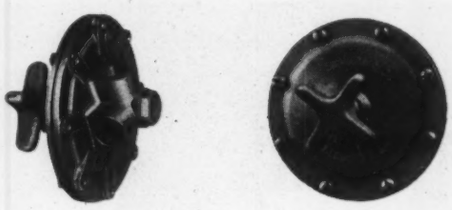
Flush Type Unit Heater Motor Controller

No. 1153—To meet the requirements of some installations where the surface type controller is not desirable, a flush type controller has been added to a line of four speed controllers for variable speed condenser motors.

The box is designed to fit into a partition wall, and is fastened as any junction box would be. The control mechanism is assembled on a separate frame; it can be removed while the box is being fitted in place and fastened with screws to the inside of the box afterward. Knockouts are provided so that wiring can be brought into the box from all four sides. Cover fits flush over the box and to the wall similar to the cover on a wall switch or outlet, and is furnished either in a black crackle or brushed brass finish. Capacities up to ⅓ hp available.—Baldor Electric Co., 4353 Duncan Ave., St. Louis, Mo.

Low Capacity Air Regulator

No. 1154—New low capacity regulator has been developed for sensitive regulation of air pressures below 30 lb. It is designed for use on applications such as pressure feed paint tanks, bubbling air into water chambers, etc. A large diaphragm with a 4 in. diameter effective area provides for increased sensitivity in regulation.

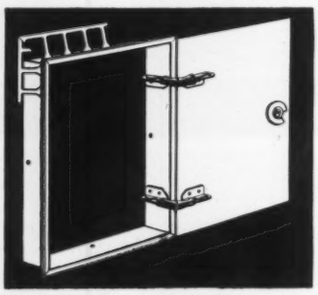


According to the manufacturer, the regulated air pressure can be graduated up to 30 lb with but 1 oz variation for each 10 lb variation of main line pressure. For example, if main line pressure varies 40 lb, regulated air pressure will vary only 4 oz.

Diaphragm is clamped in regulator body between two zinc die castings fastened together by means of radially spaced bolts. Improved valve design and construction prevents valve seat from cutting into the rubber valve.—DeVilbiss Co., 300 Phillips Ave., Toledo, Ohio.

Access Panels Have Several Features

No. 1155—New "Way Loctor" access panels incorporate a number of features. The fastener, which consists of a spiral cam, has been designed positively to open and close the door without difficulty, and the invisible hinge allows the door to open almost to 180 deg—but not quite—to protect ceiling or wall finish from injury.



The frame construction incorporates a ½ in. dust proof stop, or door seat, all around, and an effective plaster bond is provided to

MORE THAN THESE

The extensive use of welding has practically revolutionized piping design and fabrication methods. But important advances in welding do not justify the belief that almost anyone can weld anything anywhere. Experience, a high degree of skill and appropriate equipment have not been omitted from among the new requirements.

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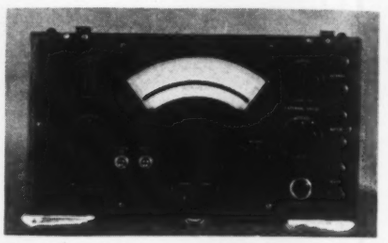
WING
WING DOOR HEATERS

help prevent cracks in plaster. The frame without the bond makes an inconspicuous job in brick or tile, states the maker.

Doors are 12 ga cold rolled steel, and there are 13 standard door sizes ranging from 8 by 8 in. to 24 by 24 in.; other sizes may be obtained on special order.—Walsh-Spencer Co., 400 Boylston St., Boston, Mass.

Anemometer for Low Air Velocities

No. 1156—"Aminco" anemometer consists of a small thermocouple, one junction of which is heated by a current of known and constant magnitude; the e. m. f. of the thermocouple is inversely proportional to the air velocity past the two junctions, because of cooling of the heated junction by the moving air. In operation, the current through the heater is adjusted and measured, the balance or "null" point with the potentiometer is determined, and the e. m. f. is read on the micro-voltmeter and converted to air velocity by means of a calibration chart.



Aside from its adaptability to the measurement of low air velocities, the instrument has the advantage that any number of anemometer units may be used simultaneously with the same potentiometer-voltammeter for remote readings of air velocities—throughout a large cold storage plant, for instance. The anemometer may be placed at practically any distance from the operator and controls. Because of the small space taken up by the anemometer element, it is particularly useful in spaces of limited size where accuracy at low velocities is important, according to the manufacturer.

The illustration shows the control panel on the potentiometer.—American Instrument Co., Inc., Silver Spring, Md.

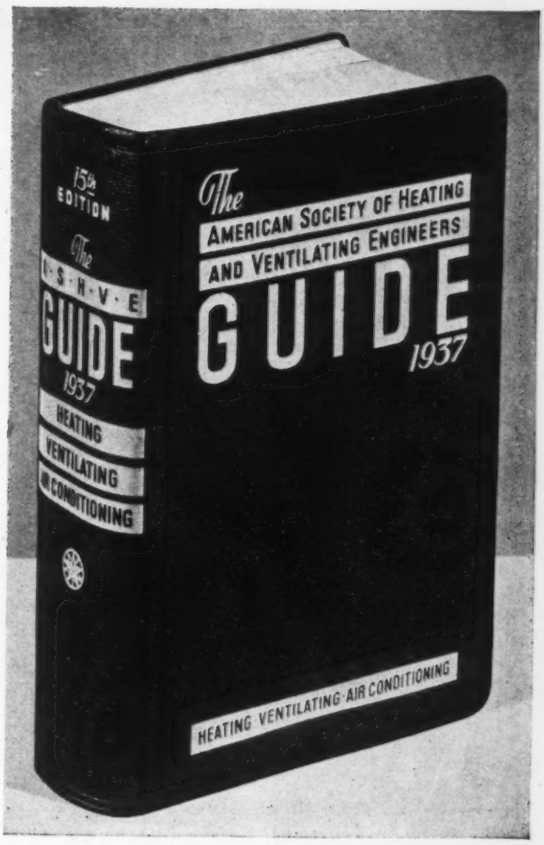
Flange Mounting Base for Motors

No. 1157—A new flange mounting for small motors makes it possible to mount the motor either horizontally or vertically with the shaft perpendicular to the mounting surface. The flange mounting is adaptable to either ball or sleeve bearing motors.

The frame with which the new mounting is used is normally rated at 1/50 hp, but lower ratings can also be furnished. This motor can be supplied with practically all types of windings regularly supplied on fractional horsepower motors.

A groove, machined to close tolerances, is provided on the face of the flange to insure accurate location and a tight fit. The flange mounting can be provided either solidly enclosed or with ventilating holes as desired.—Bodine Electric Co., 2254 W. Ohio St., Chicago, Ill.

NEW!



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THE new 1937 Edition of the A. S. H. V. E. Guide will soon be off the press.

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13. Unit Heaters, Ventilators, Air Conditioning and Cooling Units
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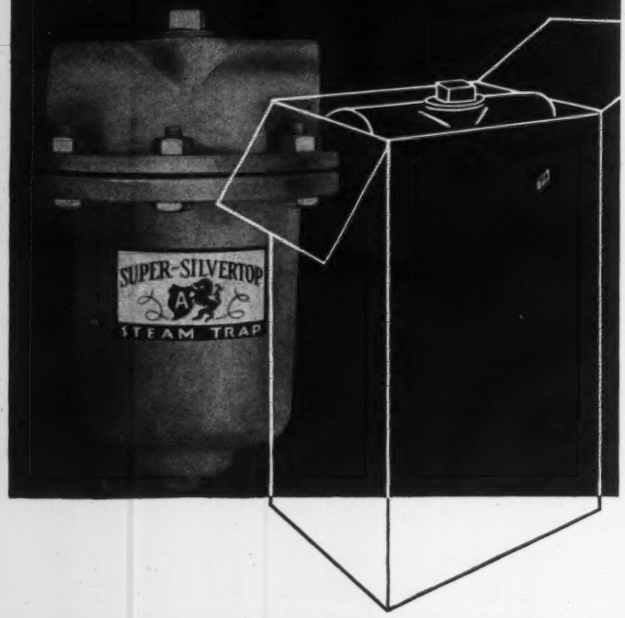

A SUPER-SILVERTOP steam trap is a package complete in itself. It requires no investment in extras such as elbows, nipples or strainer.

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Booklets, Reports and Papers

Codes for Exhaust Systems and Testing and Measuring Air Flow

The *American Foundrymen's Association* has recently approved and published two tentative codes of recommended practices developed by its industrial hygiene codes committee. These codes are the first two in a series of some 25 codes being developed to assist in the standardization of dust eliminating methods and improvement of shop operating conditions in the foundry industry. The two codes which are now available are:

36-27—Tentative Code of Recommended Practices for Testing and Measuring Air Flow in Exhaust Systems. 13 pp., 12 figs.
36-28—Tentative Code of Recommended Practices for Grinding, Polishing and Buffing Equipment Sanitation. 24 pp., 30 figs.

Code 36-27 was prepared to aid in the standardization of the general type of instruments and technique employed in determining the volume and velocity of air flow in exhaust systems. It covers the application and testing technique for pitot tubes, inclined and vertical manometer gauges, revolving vane type anemometers and swinging vane type direct reading velocity meters.

Code 36-28 describes recommended practices for the ventilation of all grinding, polishing, buffing, scratch brushing or abrasive cutting-off wheels, and grinding or polishing straps or belts and is very similar to the new State of Illinois Buffing and Polishing Equipment Sanitation Law which many of the *A.F.A.* industrial hygiene codes committee members helped to draft. A series of definitions is followed by sections on applications for hood and branch pipe requirements, design of exhaust systems, testing exhaust systems and hood and enclosure design and minimum air velocity required. The numerous illustrations will be found helpful in aiding plant engineers in designing effective equipment to meet plant requirements, especially for the smaller foundries.

Copies of these codes may be secured from the *American Foundrymen's Association,* 222 W. Adams St., Chicago, Ill., at $2.00 per copy.

The personnel of the committee which prepared these codes, is as follows: *Chairman,* James R. Allan, International Harvester Co.; J. L. Alden, Western Electric Co.; R. J. Aldrich, Sloan Valve Co.; F. H. Amos, International Harvester Co.; E. E. Birkland, Crane Co.; R. D. Brizzolara, American Steel Foundries; C. P. Guion, W. W. Sly Mfg. Co.; E. O. Jones, *American Foundrymen's Association*; Carl F. Larsson, American Air Filter Co., Inc.; C. B. Schneible, Claude B. Schneible Co.; John F. Tobin, American Blower Corp. *Conferees:* L. M. Ellison, Ellison Draft Gauge Co.; M. D. Pugh, Illinois Testing Laboratories; D. R. Hall, Gardner Machine Co.; G. P. Ransom, Ransom Grinding Wheel Co.; R. W. Young, Chas. H. Besly Co.; F. A. Zink, Kirk & Bloom.

Value of Library Air Conditioning Summarized

The life of books and manuscripts can be extended through the use of air conditioning to control temperature and humidity in libraries, according to a study made public by The Temperature Research Foundation of Kelvinator Corp., 420 Lexington Ave., New York, N. Y.

Leading librarians throughout the country were queried by the foundation to determine proper heating and ventilating conditions necessary for the efficient care of library material.

Optimum temperature for the library was set at 68 to 75 F, the humidity at 55 per cent to 65 per cent. For book stacks a slightly lower temperature and humidity is preferred.

Libraries replying to the survey agreed that air conditioning

eliminates the disastrous effects of varying and excessive heat and humidity which frequently result in the deterioration of books. Excessive heat dries the glue and loosens leather bindings, it was pointed out, while a high degree of relative humidity permits the growth of moulds, causes offensive odors and affects the paper and bindings. Newspapers and manuscripts are usually susceptible to these extremes.

The maintenance of proper temperatures and humidities in libraries is further complicated by local atmospheric conditions, It was found; a library in Miami is faced with the problem of excessive humidity, while a Denver library is forced to meet conditions of extreme heat and dryness.

Electric Institute Issues Air Conditioning Report

The *Edison Electric Institute,* 420 Lexington Ave., New York, N. Y., has issued its report on air conditioning for 1936. Copies of the 58 page report (Publication No. D12) are available from the Institute at the following prices: $1.20 to members and their employees; $3.00 to non-members in U. S. A.; $3.15 to foreign countries.

Included are five sections on factual data, cooperation with manufacturers, dissemination of statistical information for publicity, attic ventilation and circulation of air in residences, and residential air conditioning.

The section on factual data comprises 40 pages, and gives information on design conditions, design details, descriptions of the systems, data on power requirements, energy consumption, hours of operation, etc., for installations in banks, hotels, offices, office buildings, printing plants, residences, restaurants, stores and shops, beauty parlors, theaters, undertaking parlors and miscellaneous other applications in 19 states.

The section on cooperation with manufacturers outlines a plan for cooperation of electric utilities with the *Air Conditioning Manufacturers' Association,* and includes a commercial definition of the minimum requirements for air conditioning.

In the third section are outlined recommendations for a plan of assembling comparable data on air conditioning installations with minimum inconvenience to the reporting utilities. The plan provides for quarterly reports on air conditioning to be divided into seven groups, which are: Year-round air conditioning and/or summer cooling (utilizing mechanical refrigeration); evaporative and/or well water cooling; installations using ice as a cooling medium; chemical absorption systems; installations on isolated plants; winter air conditioning; and ventilation. The installations in each of these groups are to be reported under residential, commercial and industrial classifications.

The last two sections give pertinent data on attic ventilation, air circulation and air conditioning for residences.

The report was prepared by the air conditioning subcommittee of the sales committee of the Institute, of which C. E. Michel of the Union Electric Light and Power Co., St. Louis, is chairman.

Railroad Association Issues Summary Report on Air Conditioning

The division of equipment research of the *Association of American Railroads,* 59 E. Van Buren St., Chicago, Ill., has recently issued a 68 page summary report on the air conditioning of railroad passenger cars. Included is a great deal of information, much of it obtained by actual tests on air conditioned cars. The report, the first of a series, deals with those factors which are conceived to be of direct concern to the railroad executive, and about which he should be advised when formulating a policy in regard to air conditioning.

Following an introductory section with information on the present scope of railroad car air conditioning, there are sections on systems tested and results, drive mechanisms, air delivery, cost per 1,000 car-miles, and the factors relating to passenger comfort, the latter based largely upon analyses of comments made by passengers.

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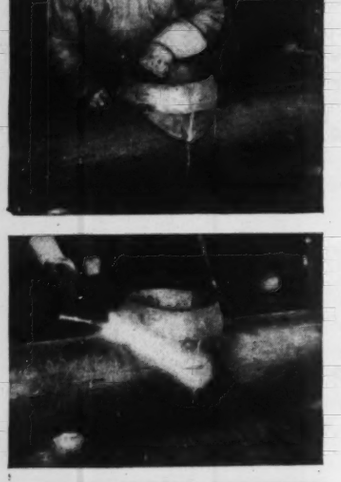
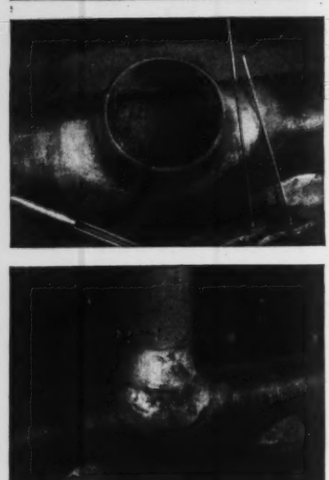
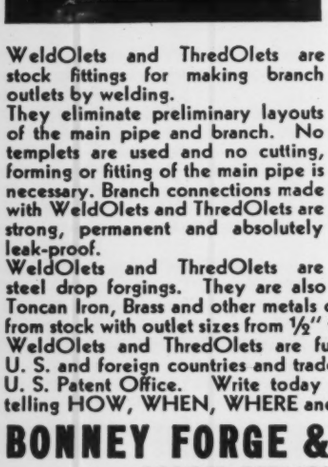
When using Weldolets or Thredolets, cutting and threading of the main pipe in taking off branch lines is entirely eliminated. Simply select the position of the outlet and weld the fitting into place.



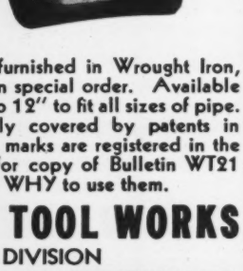
Distortion of the main pipe is eliminated due to the heavy external rib in the fitting, and a junction of full pipe strength is obtained.



The hole is cut either before or after welding the fitting to the main pipe, permitting inspection of the inside of the joint and removal of all scale, icicles, etc.



The branch line can then be welded into position with a simple Vee weld, or if Thredolets are used, screwed into place. A leak-proof joint results.



WeldOlets and ThredOlets are stock fittings for making branch outlets by welding.
They eliminate preliminary layouts of the main pipe and branch. No templets are used and no cutting, forming or fitting of the main pipe is necessary. Branch connections made with WeldOlets and ThredOlets are strong, permanent and absolutely leak-proof.
WeldOlets and ThredOlets are steel drop forgings. They are also furnished in Wrought Iron, Toncan Iron, Brass and other metals on special order. Available from stock with outlet sizes from ½" to 12" to fit all sizes of pipe. WeldOlets and ThredOlets are fully covered by patents in U. S. and foreign countries and trade marks are registered in the U. S. Patent Office. Write today for copy of Bulletin WT21 telling HOW, WHEN, WHERE and WHY to use them.

BONNEY FORGE & TOOL WORKS
FORGED FITTINGS DIVISION
Cedar & Meadow Sts. ALLENTOWN, PA.

WELDOLETS·THREDOLETS

Detailed and specific data are given on equipment and its operation, and a number of tables and curves give comparative costs and performance records.

Facts About Concrete Masonry

A 64 page bulletin, "Facts About Concrete Masonry with Construction Details," has been published by the *National Concrete Masonry Association,* 33 W. Grand Ave., Chicago, Ill. This is the sixth edition of this bulletin, the first having been issued in 1932.

Complete information is given, including data on heat transmission of concrete masonry walls, based on data obtained in a research program sponsored by the *A.S.H.V.E.* in cooperation with the *Portland Cement Association* and the University of of Minnesota. The report of this research was published in the *A.S.H.V.E. Journal Section* in the January, 1936, issue of HEATING, PIPING AND AIR CONDITIONING, under the title "Thermal Properties of Concrete Construction," by F. B. Rowley, A. B. Algren and Clifford Carlson.

Evaporative Cooling for Comfort

A 12 page paper by Walter L. Fleisher, on evaporative cooling for comfort with some references to the theory of film surfaces, was published in the December, 1936, *Journal* of the *American Society of Refrigerating Engineers,* 37 W. 39th St., New York, N. Y.

This paper describes (1) the general theory of adiabatic saturation, (2) the basis on which evaporative cooling methods may lead to comfortable conditions, (3) the theoretical method of obtaining these conditions, and (4) an apparatus that has been developed. Climatic data are given, as well as a discussion of comfort charts. In summary, at the end of the paper, the author offers a number of answers to the question of whether the material presented is warranted by timeliness and as a contribution to the present art of air conditioning.

Fan Test Code and Fan Size Comparison Chart

The *National Association of Fan Manufacturers,* 5-208 General Motors Bldg., Detroit, Mich., has printed and has available for distribution the following publications: (1) Standard Test Code for Disc and Propeller Fans, Centrifugal Fans and Blowers as prepared by a joint committee of the *National Association of Fan Manufacturers* and the *American Society of Heating and Ventilating Engineers* (price, 25c); (2) "Fair Comparison Chart" of Various Commercial Ventilating Fan Sizes.

Gas Heating Handbook

"Janitrol Sales Engineering Handbook," published by the Surface Combustion Corp., 2375 Dorr St., Toledo, Ohio. 1936. 142 *pp.,* 8½x11 *in., loose-leaf. Price, with paper cover,* $1.50; *three-ring embossed fabricoid cover,* $3.00.

To correlate and present in simple and convenient manner information on the subject of heating buildings with gas fuel is the purpose of this new handbook. It is designed to assist gas heating engineers in analyzing, planning and producing successful gas heating installations with minimum effort and a sufficient degree of accuracy.

The subjects covered include principles of heating, development of heating systems, fuels, building heat requirements, humidity, gravity warm air heating, circulated warm air heating, application of blower-filter units to existing gravity jobs, steam heating, hot water heating, conversion burners, unit heaters, venting of gas heating equipment, automatic control, heating costs and methods of reducing them, and operation of gas heating equipment. A six page glossary of heating terms concludes the book.

A. C. for Storage of Films in Libraries

Reference libraries of the future may contain files of photographic films in addition to shelves of the conventional books, if the present trend toward the use of films for recording and copying the printed word continues. Hence, it appears that librarians are to be confronted with the problems involved in the case of records on photographic films. Some of the problems have been studied at the *National Bureau of Standards*, and the findings are reported in a paper by C. G. Weber and J. R. Hill which was presented by the former at a recent meeting of the *Society of Motion Picture Engineers.*

The cellulose acetate film used as film slides for records is hygroscopic. It adjusts its moisture content to conform to the humidity of the surrounding air, and changes in moisture content affect its properties.

The film is brittle under the conditions often encountered in rooms without air conditioning, making control of the moisture content essential. The conditions suggested for storage and use of film are those recommended for the preservation of books in libraries, namely, relative humidity of 50 per cent and temperature of 70 to 80 F. However, libraries without conditioned air can get satisfactory performance by storing the film slides in humidified cabinets or small rooms in which the relative humidity is not permitted to drop below 50 per cent. Control of temperature is not considered essential, except that extreme variations should be avoided.

The emulsion side of film is easily scratched, and despite care in handling, projecting, and cleaning to minimize abrasion, film slides accumulate scratches. The positives in constant use may require occasional replacement; hence negative films of important records should be carefully preserved as a source of replacement.

Nitrate film is perishable and highly combustible. Storage of this type of film should be undertaken only in approved fireproof cabinets, and these should be within vaults of fireproof construction. Low temperature and low relative humidity are recommended to retard the deterioration of film in storage. Film containers for nitrate film should be vented to permit free escape of the products of decomposition (principally oxides of nitrogen) since their presence accelerates deterioration. It appears advisable to preserve pictures of permanent value by making negatives on acetate base, because of the perishable nature of nitrate film.

The paper has been published in the November issue of the Bureau's *Journal of Research* and also in the December *Journal* of the *Society of Motion Picture Engineers.*

Frank Lloyd Wright Designs Air Conditioned Office Building for S. C. Johnson & Son

Frank Lloyd Wright, famous for his architectural creations, has completed designs for a new office building at Racine, Wis., which will be ready for occupancy in the summer of 1937. It is designed to house the main office of S. C. Johnson & Son, Inc., makers of wax polishes. A summary of design features follows:

The plan centers around one large workroom measuring 210 ft by 130 ft, to house several hundred employees. Ceiling is 20 ft high. Girdling this room is a mezzanine gallery close to the first floor on which are located the offices of department heads and junior executives. Above this hall is a unit, a kind of penthouse on the roof, in the shape of three ellipsoidal links, containing the offices of the chief executives.

The exterior is constructed of brick of a soft-red color, of a special size, 3x9x2¼. Horizontal lines are accentuated by wide, horizontal mortar joints raked out to a depth of ½ in. and blind vertical joints of mortar the color of the brick. At a level 6 ft above the floor a band of tubular glass encircles the building, while a second band follows the rim of the ceiling. There will

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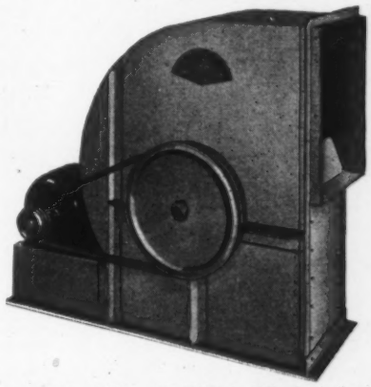
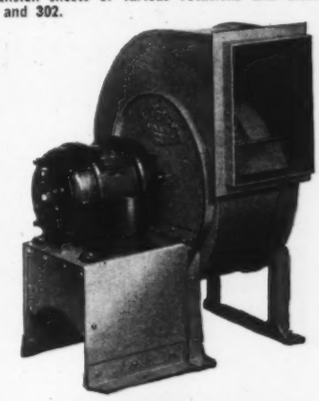
★ AUTOVENT presents a complete line of tried and proven Heating, Ventilating and Air Conditioning Equipment, backed by 25 years experience!



AUTOVENT "V" Belt Driven UNIT BLOWERS

Fan design of forwardly curved blade type. Smooth air flow, quiet bearings. Mounted on steel pedestal, built integral with housing, assuring ease of installation and flexibility of control. Air delivery can be decreased or increased. Standard Motors—Sturdy Sheet Steel Construction — Dust tight rolled lock seams. Write for Bulletin No. 300.

UNIBLADE Forward Curve and Non-Overloading Backwardly curved Belt Driven Centrifugal blowers in single and double widths with 12½" to 75" wheel diameter—available for all types of ventilating and air conditioning installations. Complete performance tables with dimension sheets of various rotations and discharge will be sent with Bulletins 301 and 302.



UNIBLADE Motor Driven BLOWERS

Ideal for elimination of foul air, fumes, gases, vapors, excess heat and steam. Direct connected motor makes for compactness and adaptability. Universal Discharge adjustable to eight positions, suitable for floor, wall or ceiling installation. Multiblade wheels with forwardly curved blades assure maximum air velocity. Write for Bulletin No. 300.

AUTOVENT "31" Series PROPELLER FANS

An exclusive Autovent designed unit which will not churn air or overload the motor. Especially recommended for economical ventilation, where greatest volume of air delivery is required at lowest cost. Ruggedly constructed for indefinite operation under severe conditions. Capacities from 500 to 38,000 CFM. Write for Bulletin No. 200.

AUTOVENT Steam UNIT HEATERS

This suspended type heater forces air circulation and directs warm air to lower part of room. Heating element is of flat copper fins attached to seamless, drawn copper tubes. Tubes run vertically for perfect drainage. No welded or brazed joints in coil or header. Fans have non-overloading power feature. Motors furnished to requirement. Write for Bulletin No. 101.

★ Autovent Engineers will gladly assist in the selection of equipment best suited to specific requirements. INVESTIGATE—WRITE FOR BULLETINS TODAY!

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1811-27 NORTH KOSTNER AVENUE
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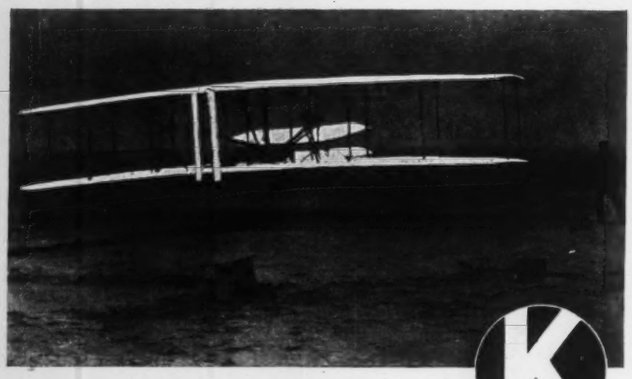
FANS • BLOWERS • UNIT HEATERS

A.I.A. FILE No. 30d



RECOGNIZED ACHIEVEMENT

● The picturesque flight of the first airplane was a distinct achievement. The high quality of "K" fittings is likewise a distinct achievement—and recognized as such.

● "K" fittings are made with machine precision. Melt is analyzed daily for closeness of grain and strength of metal. Rigid manufacturing standards and hand inspections assure uniformity and flawlessness.

● Recognize their extra value—Specify "K's"!

● Combined market facilities on both "K" cast iron and M. I. F. malleables. Complete and heavy inventories for spot shipment at Dayton, Ohio, and Branford, Connecticut.

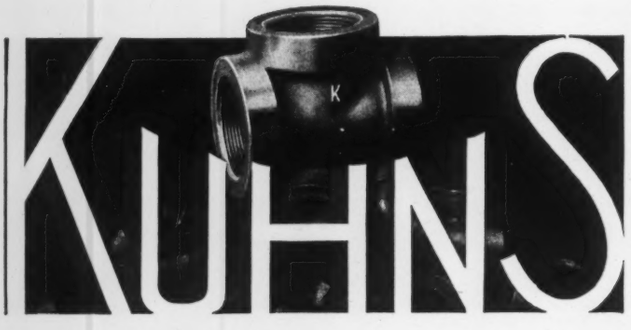
Standard and extra heavy screwed fittings, American Sprinkler fittings, standard flanged fittings, standard and extra heavy companion flanges, and drainage fittings.

Catalogue Available for Plumbers and Industrial Users.

KUHNS BROTHERS COMPANY

Dayton, Ohio

Established 1887



be no exterior openings in the building except the chambered entrance doors.

Year 'round air conditioning is provided for. The glass bands around the building will not open at any point. Intake and exhaust of air will be through two circular stacks reaching from basement to a point well above the roof. Cooling of air in summer will be accomplished by a refrigerating system.

Panel heating through the floor will represent an interesting departure from conventional heating systems. A series of brass steam coils laid below the concrete floor slab will convert the floors themselves into radiators.

Construction is on a horizontal unit system 20 ft on center both ways and a vertical unit of 3½ in. brick course. The building is fireproof, 'quakeproof, and soundproof.

The interior will show no effort to conceal the structural members of the frame. The nature of the plan is fully revealed. The exterior face brick is also used on the interior walls. The great flat expanse of paved roof will be supported by a series of slender concrete monolithic shafts with shallow, wide-spreading tops, umbrella in effect—the shafts standing tip-toe on bronze crow-feet at the floor level.

Composition roofing is in a pattern that contributes a decorative note to the building.

Cork insulation is to be used throughout building.

Fenestration, as indicated previously, will consist of two bands of glass encircling the main workroom, plus skylights. Illumination in the pent-house structure on top of the main building is similarly handled. Of particular note is the fact that these bands of glass are prismatic in structure for the purpose of diffusing the direct light, and this light comes mainly from the upper angle made by wall and ceiling.

Utilities, as well as rest rooms, toilets, and locker rooms are all located below the great workroom and are reached directly by the employees by a series of spiral iron stair cases.

A small theater with a seating capacity of 350 is provided on the mezzanine level. It will be used for a variety of purposes including the showing of moving pictures, slide films, and for radio auditions, and will be completely equipped.

Orientation is an innovation in that the entrance is interior to the lot and faces the architectural parking area which is designed in keeping with the main structure, roofed, and enclosed. The main building is set back from the street fronts 14 ft on all sides and this area is treated as a parterre, planted with low shrubs and perennials.

Total estimated cost is over $250,000. Total cubage, approximately 900,000. The erection of the building will mark the fiftieth anniversary of the founding of the owner's business.

According to Mr. Wright, "Everyone interested in building uses the term 'modern architecture.' Usually it means something 'streamlined from the outside'—that is to say something smoothed flat, all ornament omitted, the corners cut out for window openings and gas pipe railings put on wherever they will ride. The thought in the building too often does not change from antiquated conventional ideas. 'Modernity,' so called, is achieved as the new look of something old rather than the new look of something really new.

"This new Johnson building, on the contrary, will be a highly developed synthesis of form and idea—more highly developed than has been possible in the past because it is a building without windowed walls. It consists of a great workroom breathing from above through two nostrils; a building having dignified character and appropriate proportions, so complete in itself that it should be in no way inferior in harmony to the ancient cathedral.

"This new building will be simply and sincerely an interpretation of modern business conditions designed to be as inspiring to live in and work in as any cathedral ever was to worship in. The building will stand as an authentic example of modern American architecture, true to the traditions of that architecture as they actually exist."

Welded Piping System for Handling Syrup

AN interesting pump and piping system of welded construction was recently installed by the pipe crew of a corn syrup products manufacturing plant. The work involved the fabrication of a system for unloading syrup from tank cars and boats, transferring it to storage tanks and the refinery, and also for loading in cars and boats.

As the diagrams show, the system was designed to take care of a rather involved flow of syrup. The syrup is delivered to the plant in tank cars and by boat. This must be pumped either to the refinery or to storage tanks.

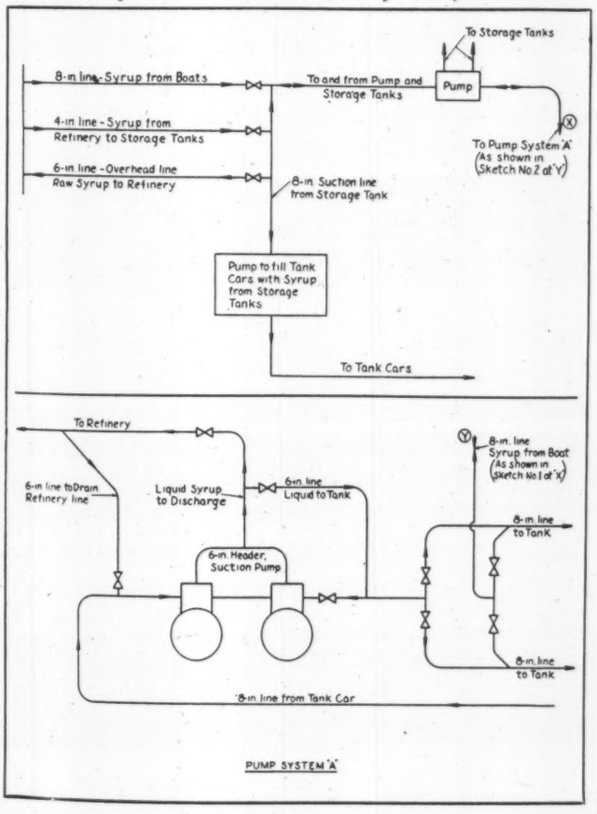
The pumps that handle this heavy sluggish liquid are operated by steam. They have a rated capacity of 100 gpm but are ordinarily operated to pass about 1,000 gal in 45 minutes.

The piping for this system required a total of 359 welds in various diameters of pipe, as follows:

Pipe Diam., In.	Number of Welds
8	98
6	52
4	89
8 (brass)	20
2	100
Total	359

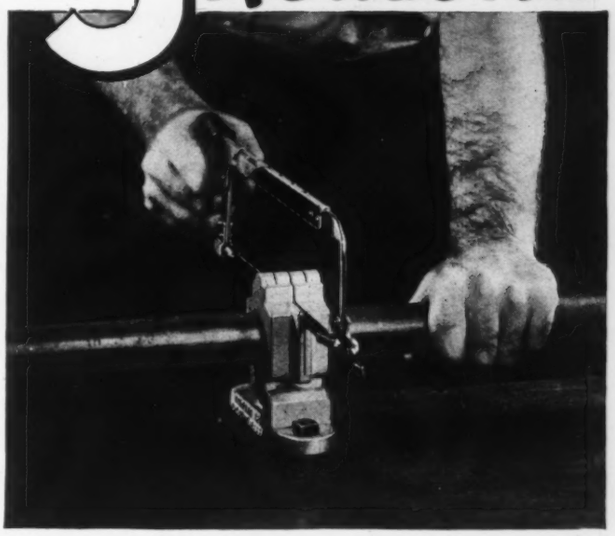
Practically all of the welds were made in position. The special fittings and bends were all made up as needed on the job. All flanges for valve connections were welded directly to the pipe ends. When the work was completed the whole system was tested hydrostatically at 300 lb per sq in. pressure.

The men responsible for pipe maintenance and installation estimate that considerable savings are realized by welding. In the case of this system, for instance, it was figured that 25 to 30 per cent had been saved in time alone. A large part of this results from the fabrication of welded specials on location.—*Oxy-Acetylene Tips.*


To Storage Tanks
8-in line - Syrup from Boats
To and from Pump and Storage Tanks
Pump
4-in line - Syrup from Refinery to Storage Tanks
To Pump System 'A' (As shown in Sketch No 2 at 'Y')
6-in line - Overhead line Raw Syrup to Refinery
8-in Suction line from Storage Tank
Pump to fill Tank Cars with Syrup from Storage Tanks
To Tank Cars
To Refinery
8-in line Syrup from Boat (As shown in Sketch No 1 at 'X')
6-in line to Drain Refinery line
Liquid Syrup to Discharge
6-in line Liquid to Tank
8-in line to Tank
6-in Header, Suction Pump
8-in line to Tank
8-in line from Tank Car
PUMP SYSTEM 'A'

AIR CONDITIONING

3 Reasons



Why TRIMO SAWING VISE SET

For thin wall tubing will *pay for itself on your first*

AIR CONDITIONING INSTALLATION

1. By making every cut 100% square
2. by sizing and holding the tubing to round while it is being cut
3. and by eliminating damaged tubing which might have to be thrown away

TRIMO VISE SET SAVES ITS COST THE FIRST TIME YOU USE IT

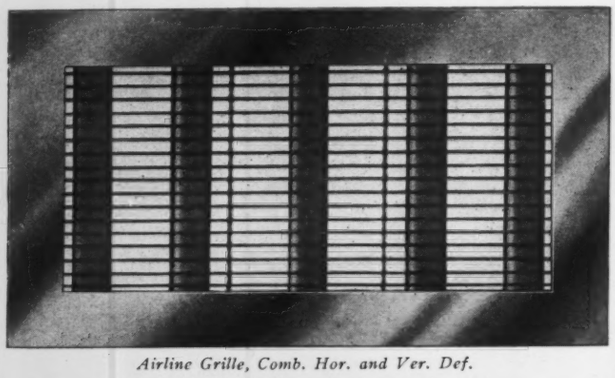
The TRIMO SAW VISE does not represent an expense—only a temporary investment—repaid in full on its first job.

This tool is made especially for such copper tubing jobs as air conditioning of cars.

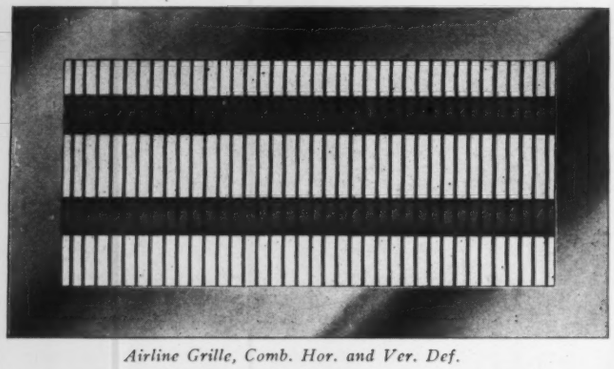
Order a Set today and take all the "grief" out of your thin wall tubing work.

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON) MASS.

THE
AIRLINE REGISTER
Free Area 74% . . . Effective Area 87%

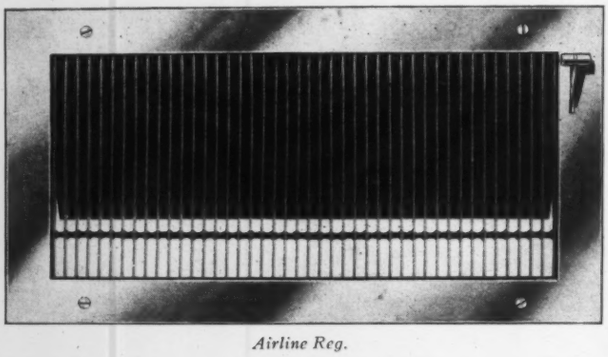


Airline Grille, Comb. Hor. and Ver. Def.



Airline Grille, Comb. Hor. and Ver. Def.

Modern in design, the Airline Register is attractive in appearance. Created especially for Air Conditioning work. It is sturdily built, is easily painted on the job, and provides a high percentage of effective area.



Airline Reg.

Special attention is called to the attractive side operator of the damper which allows the face design to be continuous. The face bars may be set to provide **fixed air deflection.**

Write for literature

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New York — Chicago
Boston — Philadelphia

Measuring Steam Consumption of Paint Drying Coils

THE EDITOR—I am employed at a plant where coil heaters are used to dry painted automobile bodies. The coils are supplied with 125 lb steam superheated 100 F.

What is the proper method for determining the horsepower requirements of these coils? The test I made was to open a return line and weigh the condensate.—J. N. S.

REPLY—Your procedure in obtaining the steam consumption of the heating coils in your paint drying ovens is correct. We assume that you are discharging the condensate into a tank containing some water, first weighing the water in the tank, then weighing it again after a timed period, the difference being the steam consumption in pounds. In this manner all condensate, including that which otherwise would be dissipated as flash steam, is accounted for.

The loss of condensate due to flash (if this flash is not recondensed) in this case would be approximately 17 per cent. The temperature of the condensate at 125 lb will be 353 F and the total heat of the liquid per lb, approximately 324 Btu. At atmospheric pressure the values are 212 F and 180 Btu, respectively. Accordingly, 173 Btu are available for the production of flash steam and will consume approximately 17 per cent of the condensate in that process.

$$\frac{173}{970 \text{ (latent heat)}} = 17\%$$

One boiler horsepower is equal to 34.5 lb of condensate.—JOHN W. HIERONYMOUS.*

*Barrett-Christie Co., Chicago, Ill.

The Editor's Page—

[*Continued from page* 71, *front section*]

dell, manager of York Ice Machinery Corp.'s Pittsburgh office, whose equipment is used. The refrigerating machinery consists of two "Freon 12" compressors, each direct connected to a 350 hp synchronous motor, and developing 356 tons refrigeration under the existing operating conditions. Five spray type dehumidifiers situated in the third basement supply conditioned air to the first and second basements and first and mezzanine floors. On the second floor a duplex dehumidifier is provided to supply conditioned air to the second and third floors. . . . Gimbel's found that during the first operating season air conditioning practically eliminated former losses in soiled garments, mark-downs, etc. (particularly in the women's ready-to-wear departments); that August sales in furs and fur trimmed winter coats are now an important percentage of the year's fur business; that an air conditioning system increases volume of sales during the summer season; that the effect of air conditioning on health as well as sales attitude of the employees is valuable and profitable; and that the fact that a store has a modern air conditioning system is evidence of a progressive management. . . . Charles Leopold of Philadelphia was the consulting engineer.

■ **More than 1.2 lb** of various dusts are precipitated in the lungs of the average man during the course of a single year, according to a study made by the Temperature Research Foundation of Kelvinator Corp. The average dust fall in a large city is approximately 230 tons per square mile per month, accord-

ing to the study. The Foundation points out the importance of air conditioning in eliminating many of the harmful components of city dust. . . . Some 10 miles of wrought iron brine piping were required for the new Hershey sports arena at Hershey, Pa. The refrigerating plant has a capacity of 90 tons. . . . Recognition of the 25th anniversary of Willis H. Carrier's presentation of his paper on psychrometric formulas was accorded him last month by the Japanese Association of Refrigeration, who voted him an honorary membership. . . . A commission as a "Texas Centennial Ranger" was also awarded Mr. Carrier last month by Governor James Allred for his part in making the Texas Centennial Exposition "an air conditioned world's fair."

■ **An engineering department** has been established by the National Coal Association, chief sponsor of the Committee of Ten—Coal and Heating Industries, as a further step in the association's active promotion of coal markets. One of the duties of the new department will be to keep in close contact with all developments concerning the better utilization of coal and coke. . . . A recommended revision of fuel oils, commercial standard CS12-35, was submitted to producers, distributors and users last month for acceptance prior to publication by the National Bureau of Standards.

■ **W. L. Rybolt,** president of the National Warm Air Heating and Air Conditioning Association, declared at the association's convention last month that the shortage of skilled men would be more acute in 1937 than in 1936. . . . Members attending the meeting visited the Refrigeration and Air Conditioning Institute laboratories and shops in Chicago and were advised by Ray D. Smith, president of the Institute, that a survey among manufacturers in the air conditioning and refrigeration business indicates that there will be a need for 50,000 service engineers during the next ten years.

Conventions and Expositions

American Society of Heating and Ventilating Engineers: Annual meeting, January 25-27, Hotel Statler, St. Louis, Mo. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

Oil Burner Institute: Oil burner and air conditioning exposition and convention, March 15-19, Commercial Museum, Philadelphia, Pa.

International Association for Testing Materials: 2nd International Congress, April 19-24, London, England. Honorary Secretary, K. Headlam-Morley, 28 Victoria St., London, S.W.1.

Short Course in Coal Utilization: May 25-27, University of Illinois, Urbana, Ill. D. R. Mitchell, Department of Mining and Metallurgical Engineering, 212 Transportation Bldg., Urbana, Ill.

Smoke Prevention Association: Annual convention, June 1-4, Hotel Pennsylvania, New York, N. Y. Secretary, Frank A. Chambers, 139 N. Clark St., Chicago, Ill. Fuel burning and air pollution exhibition to be held in conjunction with convention in ballroom of Hotel Pennsylvania, May 31-June 5.

American Society for Testing Materials: Annual meeting and exhibit of testing apparatus, June 28-July 2, The Waldorf-Astoria, New York, N. Y. Headquarters Office, 260 S. Broad St., Philadelphia, Pa.

Universal Craftsmen Council of Engineers of the World: Power show and mechanical exposition, August 3-7, Hotel Stevens, Chicago, Ill. General Chairman, W. T. Walters, 7965 Phillips Ave., Chicago, Ill.

Here's why CORK

IS THE IDEAL INSULATION FOR AIR-CONDITIONED BUILDINGS

1. RESISTS HEAT PENETRATION
2. PREVENTS CONDENSATION
3. STRUCTURALLY STRONG
4. PERMANENTLY EFFICIENT

NOVOID CORKBOARD provides an efficient insulation for air ducts and many other parts of air-conditioning and ventilating systems. Composed of millions of tiny cells of entrapped still air, this efficient insulating material offers the best known barrier to the passage of heat. Its proven insulating ability assures continued low operating costs. Its unusual structural strength permits easy erection in any type of construction. And Novoid Corkboard is *permanently* efficient. Once properly installed, Novoid will provide many years of satisfactory, low-cost insulation.

For insulating cold water pipe lines in all types of air conditioning work, Novoid Cork Pipe Covering is equally efficient. If you'd like full information, and assistance in planning specific installations of Novoid Cork Insulation, write Cork Import Corporation, 330 West 42nd Street, New York City, or mail the handy coupon below.

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Please send me all the facts about Novoid Corkboard and include drawings showing methods of application to air ducts.

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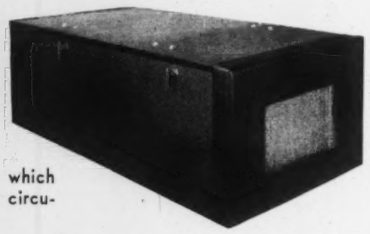
Air Conditioning Equipment

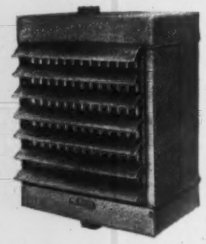
Perfectly Engineered to Meet Increasing Demands



McQUAY WINTER AIR CONDITIONING UNIT. A low cost residential air conditioning unit for use with radiator heating systems. A suspended type basement unit which filters, humidifies and circulates the air.

• ● •

McQUAY SUSPENDED AND FLOOR TYPE CENTRIFUGAL FAN TYPE COOLING AND HEATING UNITS available in 3-5-7½-10-15 and 20 ton capacity. Units are adaptable for many Air Conditioning applications.



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McQUAY UNIT HEATERS with full floating all copper heating elements are available in 34 sizes. Tubes orificed insuring equal distribution throughout element. Improved permanent bond between fin and tube.

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McQUAY CONCEALED and CABINET CONVECTORS are available in all enclosure types, exposed floor and wall hung, fully or partially recessed with removable panels and totally concealed.

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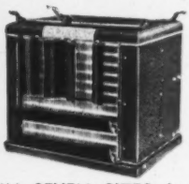

McQUAY COMFORT COOLERS available for water or brine and direct expansion refrigerants. Numerous sizes with capacities to fill your requirements.

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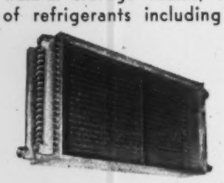

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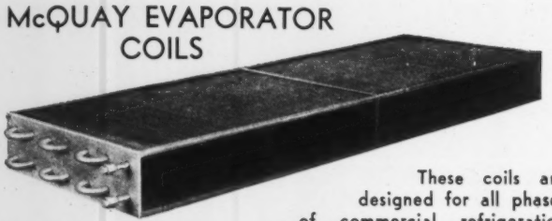

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Book Reviews

New Edition of Refrigerating Data Book

"Refrigerating Data Book and Catalog (1937-38)," *compiled by an editorial board of which David L. Fiske is editor-in-chief. Published by the American Society of Refrigerating Engineers, 37 W. 39th St., New York, N. Y. 3rd edition,* 1936, 642 *pp., 6x9 in., clothbound. Price,* $4.00 *in U. S.,* $4.50 *elsewhere.*

This third edition of the *A.S.R.E.'s* reference book on refrigerating, heat and power engineering, air conditioning, and domestic and commercial refrigeration practice is made up of four main sections—principles, high side, low side, and applications. In addition, there is a section of conversion tables and symbols, a catalog section of some 100 pages, and a list of membership of the society.

More space is devoted in the present volume to air conditioning design and practice, with new chapters on theory of ventilation and air conditioning; air conditioning equipment (washers, dehumidifiers, unit coolers); air conditioning accessories (filters, fans, ducts, etc.); air conditioning installations; air conditioning calculations; the small air conditioning job; electric motors and power equipment; piping; cooling towers; condensing units; and control. Extensive changes have been made in other parts of the book to keep it up-to-date with changes in practice.

Following are the titles of the chapters: Part 1, Principles—Thermodynamics of Refrigerating Cycles; Refrigerants; Heat Transmission; Air Conditioning Principles; Foods and Storage. Part 2, High Side—Domestic Refrigerators; Domestic Refrigerating Machines; Condensing Units and Commercial Systems; Industrial Compressors; Condensers; Atmospheric Water Cooling; Electric Power Equipment; Gas and Oil Engine Drive. Part 3, Low Side—Refrigeration Servicing; Insulation; Pipe and Piping; Evaporators, Brine Coolers, and Unit Coolers; Fans and Duct Systems; Air Systems and Air Washers; Automatic Control of Refrigeration. Part 4, Applications—Air Conditioning Practice; Industrial Air Conditioning; Small Air Conditioning Installations; Packing House Refrigeration; Beverage Refrigeration; Freezing of Foods; Storage of Perishables; Refrigeration in the Dairy Industry; Ice Manufacturing; Low Temperature Applications; Railway Refrigeration; Refrigeration Statistics; and Refrigerating Glossary.

Flow Meter Engineering Handbook

"Flow Meter Engineering Handbook," by Louis Gess and J. O. Feldmark. Published by the Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Wayne and Roberts Aves., Philadelphia, Pa. 1936. 162 *pp.,* 7½x10¼ *in., Spanish grain leather binding. Price,* $2.00.

This convenient reference handbook has been published to cover the principles of flow meter engineering, design of equipment of the "differential head" type, its applications, proper installation, and operation. Data are presented on the various types of fluid measuring equipment using the orifice and numerous examples of how to compute orifice sizes for different fluids are given.

To facilitate the use of the information, the book is divided into eight parts: General Flow Meter Engineering; Orifice Design; Steam Flow Measurement; Water Flow Measurement; Liquid Flow Measurement; Air and Gas Flow Measurement; General Tables and Data; and Summaries of Symbols, Equations and Tables.

Numerous tables, charts, digrams and photographs are included and are arranged to enable practical, everyday use of the handbook.

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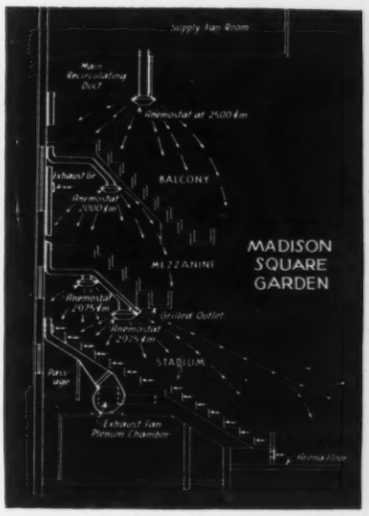

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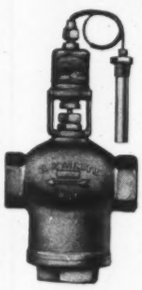

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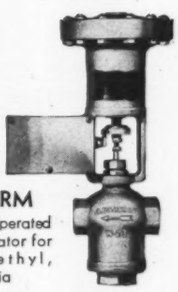

TYPE SPFA
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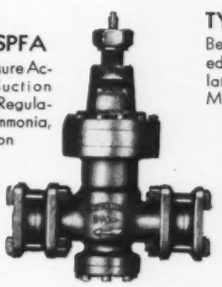
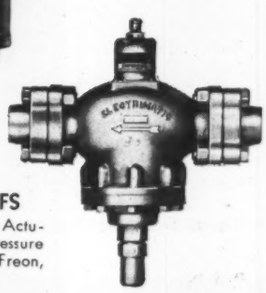


TYPE WRBP
Bellows Operated Water Regulator for Freon, Methyl, Sulphur, Ammonia

TYPE SPFS
Inlet Pressure Actuated Suction Pressure Regulator for Freon, Methyl



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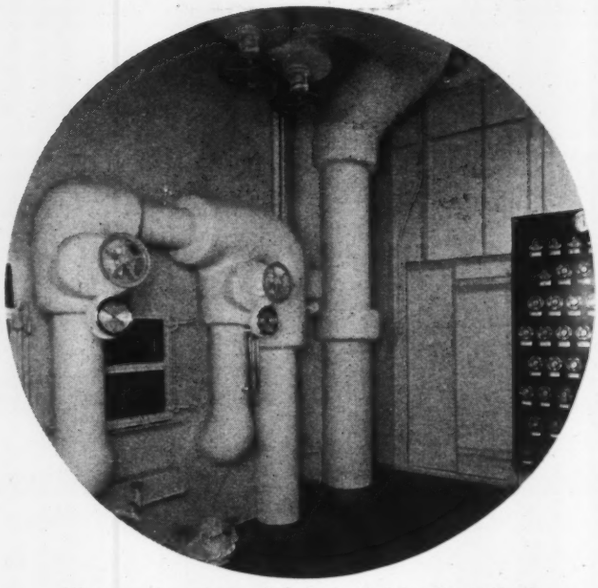

Illustration shows "Jointite" Moulded Cork Pipe Covering with canvas finish.

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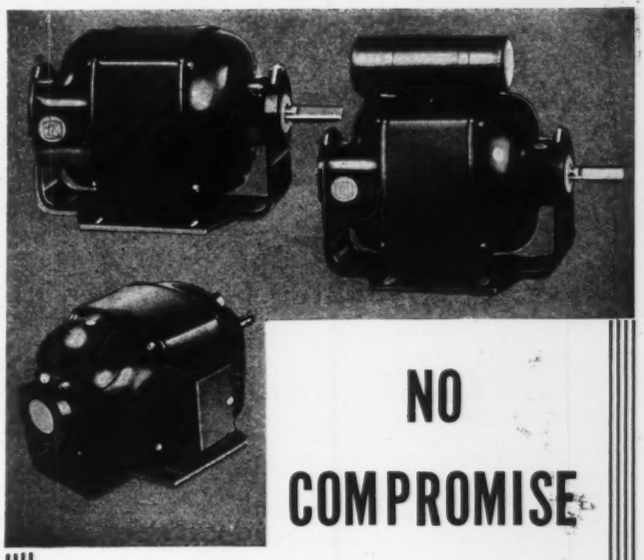

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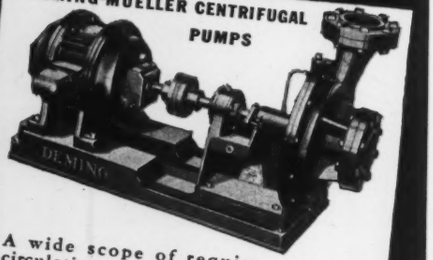

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New Keenan-Keyes Steam Tables

"Thermodynamic Properties of Steam (Including Data for the Liquid and Solid Phases)", by Joseph H. Keenan, Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, and Frederick G. Keyes, Chairman of Department of Chemistry and Director of Research Laboratory of Physical Chemistry, M.I.T. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1936. 89 pp., temperature-entropy chart, and Mollier chart. 7¼x10 in., clothbound. Price $2.75.

The present tables constitute a more complete and useful compilation than has heretofore been available. Large gaps in the previous experimental work have been filled in, and the regions investigated have been extended, results of research both here and abroad being included. The range of temperature (1600 F) and of pressure (5500 lb per sq in.) should be sufficient, the authors believe, for a long period. The inclusion of data for the liquid phase is an innovation.

The following tables are given: Saturation—temperatures; saturation—pressures; superheated vapor; compressed liquid; saturation—solid-vapor; viscosity; heat conductivity; conversion factors; thermometer calibration formulas; logarithms to the base 10; logarithms to the base *e*.

A sketch of the sources of data and an outline of the methods used in preparing the tables is given in the introduction, which discusses the temperature scale and some general equations, the vapor pressure of liquid water and of ice, properties of water vapor, and the viscosity and heat conductivity of water vapor.

A. S. T. M. Publishes Book of Standards

"A.S.T.M. Standards; Part 1, Metals; Part 2, Non-Metallic Materials." Published triennially by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Part 1, Metals, 898 + xvii pp., 6 x 9 in., clothbound. Part 2, Non-Metallic Materials, 1477 + xxvi pp., 6 x 9 in., clothbound. Prices, either part, $7.50; both parts, $14.00.

This triennial publication contains all of the standard specifications, methods of test, recommended practices and definitions formally adopted by the *A.S.T.M.* In each part, the specifications for a particular class of material are given first, followed directly by the test methods, definitions, etc. A complete subject index lists each standard under the principal subject covered, with the keywords in alphabetical sequence. This index, together with two tables of contents, one listing standards by the materials covered, the other in order of sequence of the serial designations facilitates the use of the book.

Of the 181 standards in Part 1, 109 cover the ferrous metals, steel, wrought iron, pig iron and iron castings and ferro-alloys, while 60 relate to non-ferrous metals, including aluminum and magnesium alloys, copper and copper alloys, lead, nickel, zinc, bearing metals, solder metal, deoxidizers, electrical-heating and electrical-resistance alloys. Twelve of the standards involve metallography and general testing methods.

Included in the 335 standards in Part 3 non-metallic materials, are specifications and test methods covering the following general classes of materials: cement; lime; gypsum; masonry building units (brick, building tile and stone); refractories and fire brick; pipe and drain tile; concrete and concrete aggregates; coal and coke; timber and timber preservatives; naval stores; paints, varnishes, lacquers and related products; petroleum products and lubricants; road materials; waterproofing and roofing materials; rubber products; textile materials; electrical insulating materials; and thermometers.

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Left—Servel Model WAV-2000
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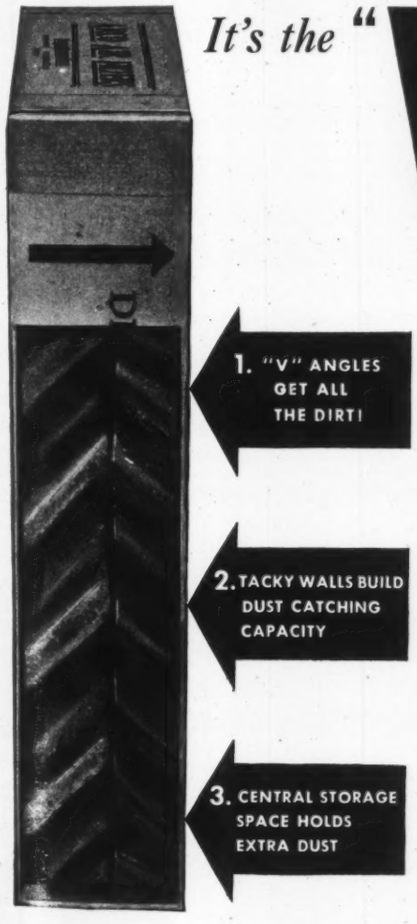

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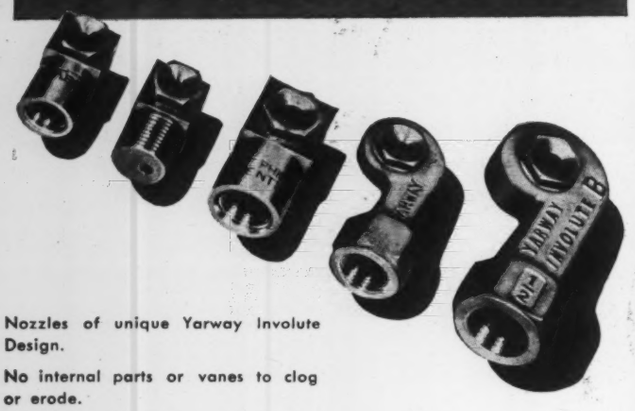

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No internal parts or vanes to clog or erode.

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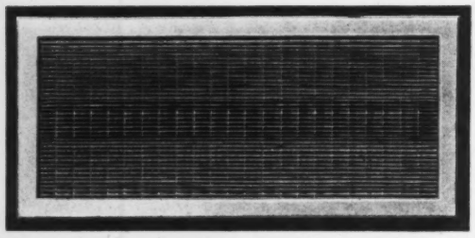

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Heating and Air Conditioning Buildings

"Heating and Air Conditioning of Buildings," by Oscar Faber and J. R. Kell. Published by The Architectural Press, 9 Queen Anne's Gate, Westminster S.W.1, London, England. 1st ed., 1936. 434 + xiii pp., 6x9 in., clothbound. Price 25s.

During 1935 the authors contributed a series of articles on this subject to the *Architects' Journal,* and in view of the interest aroused, it was thought desirable to incorporate and amplify the material in book form. This work should become a standard text and reference on British practice, as the authors are complete and authoritative in their treatment.

Chapters on the following subjects are included: General considerations and problems in connection with heating, considerations affecting the choice of heating systems, descriptions of types of heating systems, boilers and combustion, boiler mountings, chimneys, heating calorifiers (heat exchangers for heating water with steam), oil firing, warming by hot water, hot water supply and piping, heating and hot water supply by gas and by electricity, heating by steam, operating costs, air conditioning and refrigeration. The last chapter is devoted to combined electrical generating plants in which is considered the case of a building or group of buildings for which electricity is generated by a private station, the waste heat from the generating plant being used for building heating.

American and British practice of course differs. In fact, the authors point out the causes for divergence in their discussion of heating by steam, where they note that tendencies in the two countries are in opposite directions, in America being the use of smaller units using the principle of convection, and in England the trend being toward larger and more extended heat emitting surfaces relying on the principle of radiation. These causes are, they state, that roughly 2½ times the amount of heat must be supplied in cold countries (with outside temperatures of 0 F and below) as is required in England; with low temperature surfaces, the large areas would often be difficult to accommodate. The height of buildings common in America gives steam an advantage over water.

American engineers will, however, find much of value and interest, particularly on methods with which they are not familiar. Several unusual installations are described, including the heating system for the Liverpool Anglican Cathedral, where air is warmed by a furnace and circulated through ducts beneath the floor. It has been found that an average floor temperature of 68 F is all that is necessary to maintain 60 F in the Cathedral in the "coldest weather," though occasional cold spells are balanced out by the enormous reservoir effect of the structure. A special convecting system counter-acts down drafts from the large windows.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 202.

No. 2227. ACETYLENE: Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y. 12 p. booklet on "Airco" acetylene, a fuel gas for welding and cutting, presenting its history, heating efficiency, heat values, and diagramming comparative consumption of oxygen by various fuel gases.

No. 2228. AIR CONDITIONING: Carrier Corp., 850 Frelinghuysen Ave., Newark, N. J. 12 p. bulletin on modernizing and merchandising with air conditioning, describing various types of units for ceiling, wall and floor mounting, and illustrating use of compressors and evaporative condensers. Duct work and cooling coil headers are diagrammed. This publication is designed to be helpful to stores, restaurants, theaters, funeral parlors and other places where air conditioning has demonstrated its profit possibilities.

No. 2229. AIR CONDITIONING COILS: Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y. Issue of "Fedders News,"

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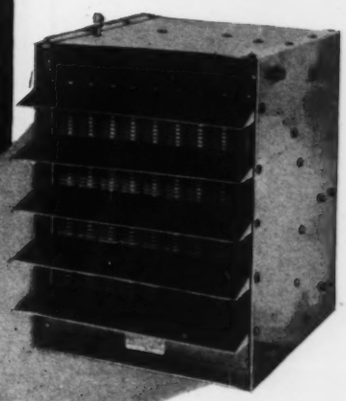

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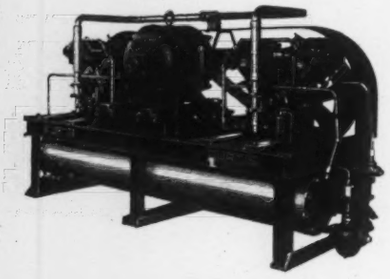

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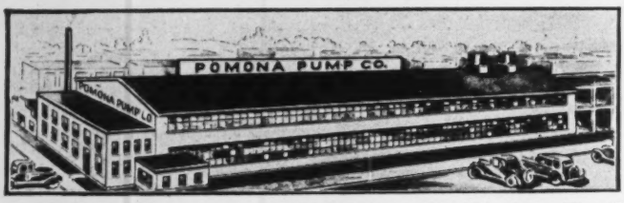

Quality Always . . . Now Fast Delivery, Too!

New Pomona Factory at St. Louis

Pomona Pumps originated in the West—to meet severe and imperative conditions for controlled irrigation. As the result of their fundamentally correct design and operating fitness, the story of their dependability went round the world and reached every industry and occupation that needs water.

Time became as important as quality, and in addition to the constantly expanding plant in the West, Pomona was obliged to open a new and complete plant in St. Louis, centrally located. Overnight deliveries are guaranteed to all points within 300 miles, and any point in the nation can be reached in forty-eight hours or less.

The most modern equipment has been installed, much of it especially designed for Pomona processes. A competent engineering staff has been assigned to the new plant and skilled artisans and mechanics with Pomona training will take care of production. Now you can get Pomona quality and fast delivery too.

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Principal Manufacturing Plant and General Offices
206 East Commercial Street • Pomona, California, U.S.A.
Eastern Manufacturing Plant: 4301-7 S. Spring Ave., St. Louis, Mo., U.S.A.
Distributing Branches in all Principal Cities

POMONA TURBINE PUMPS

(Vol. 3, No. 12) presenting a study of the effect of different variables on cooling capacity of water type air conditioning coils, by Joe Askin, chief engineer.

No. 2230. AIR FILTERS: Independent Air Filter Co., 215 W. Ohio St., Chicago, Ill. Looseleaf file of bulletins on "Double Duty" automatic air filters for large capacity, heavy duty jobs, and "Kompak" fabric air filters with renewable medium for general ventilation, industrial air cleaning, diesel engines, air compressors, etc. Data sheet on "Permo" air filters which are washable, waterproof and acidproof is included.

No. 2231. ALLOYS: International Nickel Co., Inc., 67 Wall St., New York, N. Y. 48 p. guide book to "Monel" and other non-ferrous nickel alloys, describing the solution of numerous typical problems and covering the corrosion resistance and other properties of these metals. In addition to standard "Monel," information is given on the newer forms of this alloy, including "K" and "S," on the non-magnetic forms of the metal, and on "Inconel," a high nickel chromium alloy. Subjects upon which information is given include meters and other regulating equipment, sewage disposal, pump maintenance and other items of general interest.

No. 2232. BOILERS: Edge Moor Iron Wks., Edge Moor, Del. 20 p. catalog of steam generating equipment, including water tube boilers, water walls, air preheaters and waste heat boilers, describing and illustrating in detail the various types and their applications.

No. 2233. BOILERS: National Radiator Corp., 221 Central Ave., Johnstown, Pa. 16 p. bulletin on "Premier" steel boilers, describing design and features and giving engineering data on the various types, including oil fired, stoker fired and hand fired.

No. 2234. BOILERS: Pierce Butler Radiator Corp., 701 Nichols Ave., Syracuse, N. Y. 4 p. bulletin on "Pierce Oil No. 2," a larger boiler specifically designed for oil firing, describing features of design and giving dimension table.

No. 2235. COMBUSTION CONTROL: Defender Automatic Regulator Co., 308 S. 8th St., St. Louis, Mo. 28 p. agent's pocket catalog, illustrating this company's combustion control equipment and regulators, as well as various combustion instruments.

No. 2236. CONDENSER TUBES: Bridgeport Brass Co., E. Main St., Bridgeport, Conn. 52 p. condenser tube manual, giving a short history of admiralty tubes, data on selection of condenser tube material, applications in specific industries, general specifications for condenser tubes of many materials, and a technical data section on condenser design. Tables of weights and other properties of brass and copper pipe and copper water tube are included.

No. 2237. DRIVES: Dayton Rubber Mfg. Co., 2345 W. Riverview Ave., Dayton, O. 40 p. catalog on "Cog Belt" and V-flat drives, giving complete data and prices on "Cog Belt" drives, "Cog Belt" drives with "Day-Steel" pulleys, and V-flat drives. Proper combinations of belts and pulleys to meet various drive conditions are listed for the easy selection of drives from fractional to 1000 hp and over.

No. 2238. DRIVES: Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. 96 p. data book on "Silverstreak" silent chain drives of fractional hp up to 2000 hp, including installation pictures, engineering data, recommendations for drive selection, information on lubrication and casings, dimensions of chains and parts, and list prices.

No. 2239. GAS CONVERSION BURNERS: Surface Combustion Corp., 2375 Dorr St., Toledo, O. 8 p. bulletin giving specifications on "Janitrol" conversion burners.

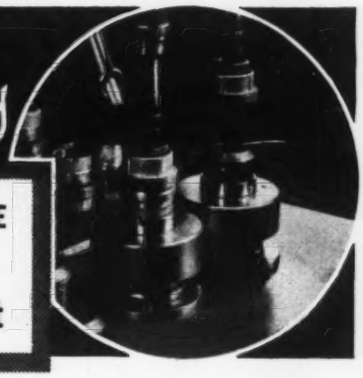
No. 2240. GAS FIRED CONDITIONERS: Surface Combustion Corp., 2375 Dorr St., Toledo, O. 12 p. bulletin giving specifications for "Janitrol" gas fired conditioners and gravity heaters.

No. 2241. GAS VALVES: Penn Electric Switch Co., 2000 E. Walnut, Des Moines, Ia. 4 p. bulletin describing features of power gas valves, and giving diagrams, specifications, ratings and capacities.

No. 2242. HEAT EXCHANGE EQUIPMENT: Patterson-

Here's Why

DARTS HAVE A True Ball Joint



This extra manufacturing process pays you dividends in extra union service. To produce two bronze seats that remain tight-sealed as often as removed and reinstalled, Dart engineers designed these special oscillating grinders. On them, Dart's special bronze is ground to spherically accurate surfaces that maintain a full, true bearing over every point of the seating contact . . . precluding any chance of leakage.

And against breakage, distortion and stretch, protection is provided by Dart's heavy body and nut of air-refined malleable iron.

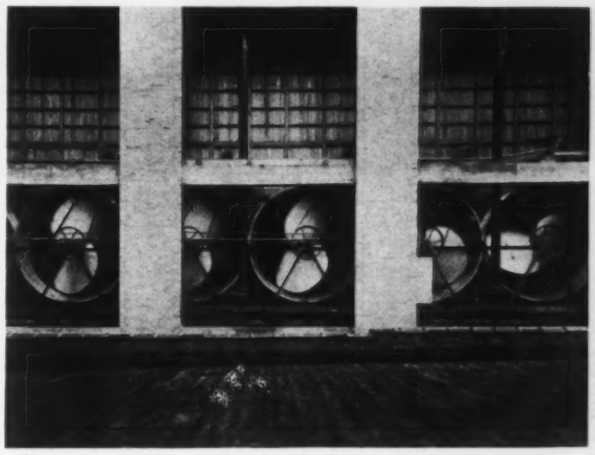
These features are found only in Darts. And only in Darts will you find true union economy. Tell us what size you use most . . . we'll send you one to test.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches. Canadian Factory: Dart Union Company, Ltd., Toronto, Canada.

SELECT
LILIE-HOFFMANN
COOLING TOWERS



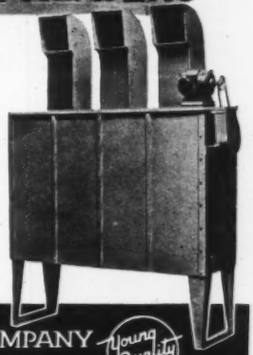
Lilie-Hoffmann cooling towers have established a record for efficiency, reliability and sturdy construction, and boast thousands of satisfied customers. A few outstanding installations made recently include the St. Louis Municipal Auditorium; Sears, Roebuck & Co., St. Louis (two installations); Rich Department Store, Atlanta, Georgia.

20 Years Experience • WRITE FOR BULLETIN

Lilie-Hoffmann Cooling Towers, Inc.
4948 Reber Place St. Louis, Mo.

UNIT HEATERS
BLAST HEATERS
COMMERCIAL HEAT TRANSFER SURFACES

MODERNIZE YOUR HEATING PLANT WITH Young UNIT HEATERS



Either the suspension or floor models will provide a most satisfactory and economical method of heating all types of industrial buildings. Young Blast Units and Commercial Units are designed to operate in conjunction with central fan systems for either heating, cooling, or air conditioning. All Young heating and cooling units are available in many sizes and capacities to fill the most exacting specifications.

OFFICES IN ALL PRINCIPAL CITIES

YOUNG RADIATOR COMPANY
RACINE . WISCONSIN
Young Quality

AMERICAN-MARSH

PUMPS

Centrifugal, Steam and Power Pumps in types and sizes to meet every requirement. Built of the finest materials —tested and guaranteed — backed by 63 years' experience.

Whatever your pumping problem, it will pay you to consult us. Write for Bulletins.

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN . . . Pumps and Pumps Only Since 1873

● **THE GENERAL B-6** semi-balanced valve is the ideal solenoid for zone control of hot water heating systems.

● **DEPENDABLE POWER** Fully powered, of packless construction with no pawls or catches to fail, the GENERAL B-6 operates dependably year-in, year-out.

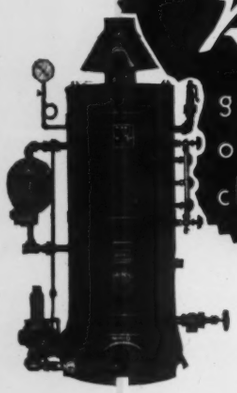
● **QUIET OPERATION** Closing with a steady, delayed action, there is no trace of noisy on-and-off "banging." The solenoid also is entirely quiet.

GENERAL CONTROLS
1505 BROADWAY CLEVELAND, OHIO • 1370 HARRISON STREET SAN FRANCISCO, CALIF.

ORIGINATORS OF THE QUIET A. C. SOLENOID

Looking for a "sure thing"? • • •

Certified Performance Reports give ample proof of all that is claimed for it!



● The KANE'S unequalled economy in operation and maintenance . . . its labor saving convenience . . . its dependability and long life . . . its ability to maintain a constant pressure of clean steam, with but a very few minutes manual attention a day . . . are *proven* merits, substantiated by conclusive evidence readily available to you!

● We'd like to give you the facts. Write today . . . and ask about the OFELDT Boiler and the M.K.O. Boiler Feed, too. There's no obligation.

KANE AUTOMATIC GAS - FIRED STEAM BOILERS

MEARS-KANE-OFELDT INC.

Executive Offices and Factory
1903-1915 EAST HAGERT ST., PHILADELPHIA
Branch Offices or Distributors in Principal Cities

Kelley Co., Inc., East Stroudsburg, Pa. Leaflet briefly describing and illustrating various types of fuel oil heaters, heat reclaimers, combined hot water service and storage heaters, instantaneous heaters, condensation coolers, etc.

No. 2243. MECHANICAL RUBBER GOODS: B. F. Goodrich Co., Mechanical Rubber Goods Div., 548 S. Main St. Akron, O. 27 p. buyer's guide to "Diamond" mechanical rubber goods, describing and illustrating over 50 products and accessories, including transmission and conveyor belting, hose and fittings, tubing, packing, cements and matting.

No. 2244. OIL TESTING INSTRUMENTS: C. J. Tagliabue Mfg. Co., 540 Park Ave., Brooklyn, N. Y. 24 p. catalog of "Tag" oil testing instruments for petroleum products, listing and describing this company's complete line of oil testing instruments, hydrometers, thermometers, etc.

No. 2245. OXYGEN LANCES: Linde Air Products Co., Unit of Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y. 8 p. booklet giving in convenient form information on oxygen lances and their uses, which include the accurate piercing of small holes, use as a supplementary tool in cutting large sections to shape, etc.

No. 2246. PIPE FITTING INDICATOR: Pittsburgh Piping & Equipment Co., 43rd St. & A. V. R. R., Pittsburgh, Pa. Novel pipe fitting indicator, giving dimensional information for Series 15, 30, 40 and 60 flanged piping.

No. 2247. PUMPS: Nash Engineering Co., South Norwalk, Conn. (a) 8 p. bulletin on "Jennings" condensation pumps in a variety of designs to meet requirements of handling hot condensate from steam systems for heating, drying and process work. (b) 8 p. bulletin on "Jennings" vapor turbine vacuum heating pumps, designed to operate without electric current. (c) 8 p. bulletin on vacuum pumps with one moving part and no valves or pistons, which handle liquid with gas and which do not require internal lubrication. Complete descriptions of features, section diagrams and tables of rating, capacity and power requirements are included.

No. 2248. RADIATORS: Burnham Boiler Corp., Main St., Irvington, N. Y. Booklet giving ratings for this company's complete line of tube type and "slenderized" radiators, designed for the convenience of estimators, contractors, engineers and salesmen.

No. 2249: REGULATORS: Marsh Tritrol Co., 720 N. Michigan Ave., Chicago, Ill. 12 p. booklet describing method of controlling building heating systems to prevent overheating, which automatically adjusts hours of regulation to suit weather conditions. Construction, operation and application of the instrument to various types of heating systems are described, and the performance of an installation in a large office building is discussed.

No. 2250. SHEETS: American Rolling Mill Co., 703 Curtis St., Middletown, O. 4 p. bulletin on "Armco" galvanized "Paintgrip" sheets which are readily paintable without special acid treatments or weathering. Forming qualities, soldering practice, and welding, cleaning and finishing operations are explained.

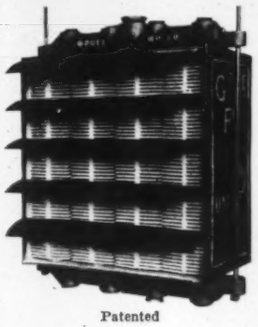
No. 2251. SOLENOID VALVES: Automatic Switch Co., 154 Grand St., New York, N. Y. 32 p. catalog of solenoid operated valves for the automatic and remote control of air, gas, steam and liquids, describing many types, giving general service recommendations, specifications and other data.

No. 2252. STEAM TURBINES: Allis-Chalmers Mfg. Co., Milwaukee, Wis. 20 p. bulletin on high back pressure, non-condensing steam turbine units of the three valve reaction type for furnishing steam for high pressure process work. Construction features are described in detail and many drawings and photographs are included.

No. 2253. TOOLS: Bonney Forge & Tool Wks., Tilghman & Meadow St., Allentown, Pa. 50 p. looseleaf catalog of this company's "Industrial" wrenches and tools, including chisels, lathe dogs, hammers, pliers, punches, screw drivers, various types of wrenches, etc.

No. 2254. UNIT HEATERS: Surface Combustion Corp., 2375 Dorr St., Dayton, O. 12 p. bulletin giving specifications on

"THESE HEATERS HAVE Eliminated ALL OUR WALL RADIATION—



Patented

And have required no maintenance in the 5 years they have been installed in our plant" (Name on request).

In addition to eliminating wall radiation "GRID" Unit Heaters have furnished comfortable warm air to floor and lower portion of the plant. There has been no maintenance expense, because "GRID" Unit Heaters are made to last—all cast aluminum heating sections that positively eliminate electrolysis and corrosion. In them there are no unions, soldered, pressed or rolled joints, and the fewest connections possible. Complete details on request, with a story of why in 8 heating seasons there have been no failures due to leaks or breakdowns.

THE UNIT HEATER & COOLER COMPANY
WAUSAU, WISCONSIN
Offices in all principal cities.

GRID
UNIT HEATER

AFFILIATED COMPANIES

LAYNE-ARKANSAS CO., STUTTGART, ARK.—LAYNE-ATLANTIC CO., NORFOLK, VA.—LAYNE-CENTRAL CO., MEMPHIS, TENN.—LAYNE-NORTHERN CO., INC., MISHAWAKA, IND.—LAYNE-LOUISIANA CO., INC., LAKE CHARLES, LA.—LAYNE-NEW YORK CO., INC., NEW YORK CITY—LAYNE-NORTHWEST CO., MILWAUKEE, WIS.—THE LAYNE-OHIO CO., COLUMBUS, OHIO—LAYNE-BOWLER NEW ENGLAND CO., BOSTON, MASS.—LAYNE-TEXAS CO., HOUSTON, TEX.—LAYNE-WESTERN CO., KANSAS CITY, MO., CHICAGO, ILL., AND MINNEAPOLIS, MINN.—INTERNATIONAL WATER SUPPLY LTD., FORT ERIE, N., ONTARIO, CANADA.

FOR fifty-four years Layne has enjoyed world-wide leadership in the field of water development. No other water supply organization can claim such an incomparable achievement—no other has accumulated such a rich fund of experience. Today, Layne Pumps and Well Water Systems are the standards of comparison.

Air conditioning engineers who are contemplating more . . . or better water producing facilities should call in a Layne hydrological engineer or write Layne & Bowler, Inc., Dept. K, Memphis, Tenn.

LAYNE PUMPS
LAYNE WELL WATER SYSTEMS

MONCRIEF
Air Conditioning
PIPE AND FITTINGS CATALOG

NEW

Send for Yours Today

You need this valuable data book in your air conditioning business. It will make estimating easier and help you lower the costs of the complete installation . . . and the Moncrief patented lock joints on wall stacks, stack heads, footpieces and trunk duct fittings make a more efficient, neater job that is easier to install.

The Henry Furnace & Foundry Co.
3480 E. 49th St., Cleveland, Ohio

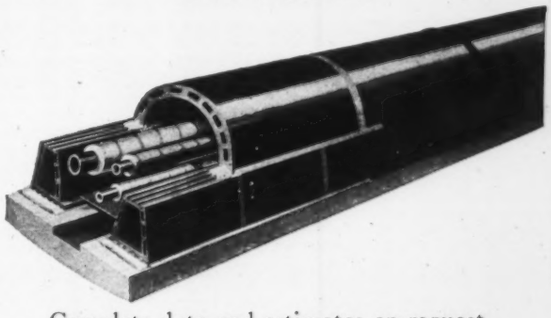
NOW
MORE COMPLETE THAN EVER

Write for this valuable book today

THERM-O-TILE

The Conduit for Underground Steam Lines

Simplest
Strongest
Most Efficient



Complete data and estimates on request.

Sold and Installed by Johns-Manville Construction Units in all Principal Cities.

H. W. PORTER & CO., INC.
825 FRELINGHUYSEN AVE., NEWARK, N. J.

NEW! IDEAL

THERMO-GRIP PLIERS

For sweating and unsweating joints in threadless *copper pipe* and *fittings*.

ENDORSED—

by leading copper fittings manufacturers. IDEAL "Thermo-Grip" Electric Pliers are modern—practical—safer and better than open-flame soldering—inexpensive. Its many uses include making all types of small solder connections, melting solder in a thimble or pipe cap, and electrical, plumbing, heating, engineering, refrigeration, and air-conditioning installations and maintenance work.
Available for continuous work on pipe fittings up to 2½" diameter; or intermittently on pipe up to 4" diameter!

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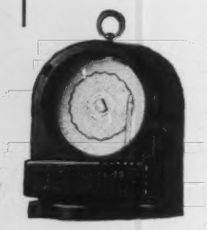
IDEAL COMMUTATOR DRESSER COMPANY
1096 Park Avenue Sycamore, Illinois

LET ME HELP YOU
for fifteen days



• I am the Practical Recording Thermometer —portable, dependable and easy to use. Hundreds of heating dealers use me in selling and service work. I give them 24 hour temperature records on a 4 inch, easy-to-read chart. Pen and bi-metal element built in door, swinging out of way when chart is changed. Let me work for you for 15 days on a trial basis. Write for information about this 15 Day Trial offer.

ask your jobber

Practical Instrument Company
2719 N. Ashland, Chicago

PRACTICAL Recording Thermometer

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FIN COILS
for Commercial Use
Pipe Coils and Bends
Rempe Co., 340 N. Sacramento Blvd., Chicago, Illinois

YOUNG
REGULATOR

The YOUNG regulator is an inexpensive convenient control for heating, ventilating, cooling or air conditioning installations.

It indicates the position of dampers regulating the flow of air through ducts. It is readily set and locked in a permanent position, positive in action and absolutely tamper proof. Made of rust-resisting metal and finished in Plain, Statuary Bronze or Nickel it presents a neat appearance.

Write now for further information.

YOUNG REGULATOR COMPANY
4500 Euclid Avenue Cleveland, Ohio

"Janitrol" gas fired unit heaters in various types with capacities ranging from 45,000 to 400,000 Btu input. Construction and operation are described, and dimension and capacity tables are given.

No. 2255. VALVES: Foxboro Co., 106 Neponset Ave., Foxboro, Mass. 28 p. catalog of valves for air operated controllers, including information on valve selection, describing and giving technical data on the several types as well as on controller accessories. Information is included on computing valve sizes, determining size of control valve when it is in a steam line to direct acting pump, and other subjects.

No. 2256. VALVES: Kennedy Valve Mfg. Co., Elmira, N. Y. Bulletin describing new line of fully bronze-bushed standard iron body wedge gate valves, describing and illustrating 33 features of design.

No. 2257. VIBRATION ISOLATION: B. F. Goodrich Co., Mechanical Rubber Goods Div., 548 S. Main St., Akron, O. 4 p. bulletin on new line of rubber-to-metal mountings ("Vibro-Insulators"), designed for application on mechanical equipment to absorb shock and vibration and to reduce noise. The three shear type mountings are described in detail, and deflection tables are included.

No. 2258. WATER HEATERS: National Radiator Corp., 221 Central Ave., Johnstown, Pa. 8 p. bulletin on submerged water heaters (tank and tankless types) for use in "National Premier" steel boilers, describing construction and operation, and giving information on how to determine hot water requirements. Typical installation diagrams and rating and dimension tables are included.

No. 2259. WELDED SEAM STRESS RELIEVERS: H. O. Swoboda, Inc., 4301 Main St., Pittsburgh, Pa. Circulars describing "Falcon" portable electric heaters for stress relieving welded seams in pressure piping, nozzle attachments, valves, etc.

No. 2260. WELDERS: Hobart Bros., Canal Lock Sq., Troy, O. 4 p. folder illustrating and describing new "Current Saver" line of arc welders which feature selective motor control.

No. 2261. WELDING AND CUTTING EQUIPMENT: Bastian-Blessing Co., 240 E. Ontario St., Chicago, Ill. 48 p. pocket size catalog of "Rego" welding and cutting equipment and accessories, including complete outfits, regulators, torches, etc.

No. 2262. WELDING WROUGHT IRON: A. M. Byers Co., Clark Bldg., Pittsburgh, Pa. 12 p. service bulletin on the welding of wrought iron, summarizing the results of a test program carried on by A. M. Byers Co. and the National Weld Testing Bureau. Detailed information is given on processes and procedures for welding wrought iron both by the oxy-acetylene and arc welding methods.

FOR YOUR CONVENIENCE

Heating, Piping and Air Conditioning,
6 N. Michigan Ave., Chicago, Ill. [1-37]

Please ask the manufacturer to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle the numbers in which you are interested):

1143	1144	1145	1146	1147	1148	1149
1150	1151	1152	1153	1154	1155	1156
1157	2227	2228	2229	2230	2231	2232
2233	2234	2235	2236	2237	2238	2239
2240	2241	2242	2243	2244	2245	2246
2247a	2247b	2247c	2248	2249	2250	2251
2252	2253	2254	2255	2256	2257	2258
2259	2260	2261	2262			

Name ..... Title .....

Company .....

Address .....

City ..... State .....

HEATING ✦ PIPING AND AIR CONDITIONING

January, 1937

DIRECTORY SECTION

HEATING, PIPING AND AIR CONDITIONING EQUIPMENT *for* INDUSTRY AND LARGE BUILDINGS

HOW TO USE THIS DIRECTORY

If you want to know the names of one or more manufacturers making a certain product, look in Part 2, where that product will appear in its proper place in the listing. If you have the trade name of a product and want to know who manufactures it, look in Part 3, where trade names are alphabetically listed. For the complete name and address of any manufacturer look in Part 4.

For a classification of the products featured and described in the advertisements in this issue, and the page numbers on which they appear, see Part 1, "Advertised Products Classified."

● The manufacturers whose names are spotted throughout the listings advertise in this issue. See Index to Advertisers on next page, for the page on which you will find the advertising of any of these manufacturers. See also Part 1.

Heating-Piping and Air Conditioning ● Chicago, Ill.

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A. C. E. Inc., Chicago, Ill.
American Instrument Co., Silver Springs, Ind.
●Friez & Sons, Inc., Julien P., Baltimore, Md. (also direct reading air meters)
●Illinois Testing Laboratories, Inc., Chicago, Ill. (also direct reading air meters)
●Taylor Instrument Companies, Rochester, N. Y.
Weston Electrical Instrument Co., Newark, N. J.

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●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●Armstrong Cork Products Co., Lancaster, Pa.
●Buffalo Forge Co., Buffalo, N. Y.
●Cork Import Corp., New York, N. Y.
●Cork Insulation Co., Inc., New York, N. Y.
Fabling Co., W. D., Los Angeles, Cal.
Felt Products Mfg. Co., Chicago, Ill.
Firestone Tire & Rubber Co., Akron, O.
General Electric Co., Schenectady, N. Y.
General Insulating Products Co., Brooklyn, N. Y.
Goodrich Co., B. F., Akron, O.
Korfund Co., Long Island City, N. Y.
Lehigh Fan & Blower Co., Allentown, Pa.
Lord Mfg. Co., Erie, Pa.
Manley Products Corp., York, Pa.
●Mundet Cork Corp., New York, N. Y.
Smidth & Co., F. L., New York, N. Y.
●Sturtevant Co., B. F., Boston, Mass.
Union Fibre Co., Inc., Winona, Minn.
United Cork Companies, Lyndhurst, N. J.
United States Gypsum Co., Chicago, Ill.
Vibration Eliminator Co., Long Island City, N. Y.

BEARINGS, BALL

Ahlberg Bearing Co., Chicago, Ill.
●Fafnir Bearing Co., New Britain, Conn.
New Departure Div., General Motors Corp., Bristol, Conn.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Schatz Mfg. Co., Fairview, Poughkeepsie, N. Y.
Shafer Bearing Corp., Chicago, Ill.
SKF Industries, Inc., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

BEARINGS, ROLLER

●Fafnir Bearing Co., New Britain, Conn.
Hyatt Roller Bearing Co., Harrison, N. J.
Medart Co., St. Louis, Mo.
Norma-Hoffmann Bearing Corp., Stamford, Conn.
Roller Bearing Co. of America, Trenton, N. J.
Shafer Bearing Corp., Chicago, Ill.
SKF Industries, Inc., Philadelphia, Pa.
Timken Roller Bearing Co., Canton, O.

BELTING, FLAT, LEATHER

Alexander Bros., Inc., Philadelphia, Pa.
Chicago Belting Co., Chicago, Ill.
Graton & Knight, Worcester, Mass.
Houghton & Co., E. F., Philadelphia, Pa.
●Rhoads & Sons, J. E., Wilmington, Del.
Williams & Son, I. B., Dover, N. H.

BELTING, FLAT, RUBBER

Continental Rubber Wks., Erie, Pa.
Dick Co., Inc., R. & J., Passaic, N. J.
Firestone Tire & Rubber Co., Akron, O.
Garlock Packing Co., Palmyra, N. Y.
Gilmer Co., L. H., Philadelphia, Pa.
Goodrich Co., B. F., Akron, O.
Goodyear Tire & Rubber Co., Akron, O.
Hamilton Rubber Mfg. Co., Trenton, N. J.
Jeffrey Mfg. Co., Columbus, O.
Manhattan Rubber Mfg. Co., Div. of Raybestos-Manhattan, Inc., Passaic, N. J.
Republic Rubber Co., Youngstown, O.
Thermoid Rubber Co., Trenton, N. J.
United States Rubber Products, Inc., New York, N. Y.

BELTS, V

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Continental Rubber Wks., Erie, Pa.
Dayton Rubber Mfg. Co., Dayton, O.
Dick Co., Inc., R. & J., Passaic, N. J.
Gates Rubber Co., Denver, Colo.
Gilmer Co., L. H., Philadelphia, Pa.
Goodrich Co., B. F., Akron, O.
Goodyear Tire & Rubber Co., Akron, O.
Manhattan Rubber Mfg. Co., Div. of Raybestos-Manhattan, Inc., Passaic, N. J.
Medart Co., St. Louis, Mo.
Ohio Valley Pulley Works Div., Browning Mfg. Co., Inc., Maysville, Ky.
Thermoid Rubber Co., Trenton, N. J.
United States Rubber Products, Inc., New York, N. Y.
Wood's Sons Co., T. B., Chambersburg, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.

BENDERS, CONDUIT AND PIPE

American Pipe Bending Machine Co., Inc., Boston, Mass.
American Pipe Tool Co., Chicago, Ill.
Bernz Co., Inc., Otto, Rochester, N. Y.
●Buffalo Forge Co., Buffalo, N. Y.
Grabler Mfg. Co., Cleveland, O.
Hays Mfg. Co., Erie, Pa. (Copper tube)
Hollands Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y.
Martin & Sons, H. P., Owensboro, Ky.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Toledo Pipe Threading Machine Co., Toledo, O.
Vanderman Mfg. Co., Willimantic, Conn.
Wallace Supplies Mfg. Co., Chicago, Ill.

BENDS, EXPANSION, STEAM PIPE

●Crane Co., Chicago, Ill.
Floersheim & Co., B., Pittsburgh, Pa.
●Frick Co., Waynesboro, Pa.
●Grinnell Co., Inc., Providence, R. I.

Harris & Co., Arthur, Chicago, Ill. (Stainless & non-ferrous)
Harrisburg Steel Corp., Harrisburg, Pa.
Kellogg Co., M. W., New York, N. Y. (Corrugated steel)
Limbert & Co., Geo. B., Chicago, Ill.
Lumsden Van Stone Co., South Boston, Mass.
●Midwest Piping & Supply Co., Inc., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
National Valve & Mfg. Co., Pittsburgh, Pa.
Ohio Pipe Bending & Machine Co., Cleveland, O.
Parks-Cramer Co., Fitchburg. Mass.
Pittsburgh Pipe Coil & Bending Co., Etna, Pa.
●Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.
Roessing Mfg. Co., Pittsburgh, Pa.
Sales & Co., Murray W., Detroit, Mich.
Shaw Co., Benjamin F., Wilmington, Del.
Shaw-Kendall Engineering Co., Toledo, O.
Vogt Machine Co., Henry, Louisville, Ky.

BI-METALS, THERMOSTATIC

Chace Valve Co., W. M., Detroit, Mich.
Dole Valve Co., Chicago, Ill.
General Plate Co., Attleboro, Mass.
Wilson Co., H. A., Newark, N. J.

BLADES, FAN

●Buffalo Forge Co., Buffalo, N. Y.
●Clarage Fan Co., Kalamazoo, Mich.
Dallas Engineering Corp., Dallas, Tex.
Economy Electric Mfg. Co., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
International Engrg., Inc., Dayton, O.
Janette Mfg. Co., Chicago, Ill.
Meier Electric & Machine Co., Indianapolis, Ind.
Myers Electric Co., Pittsburgh, Pa.
Ohio Valley Pulley Works Div., Browning Mfg. Co., Inc., Maysville, Ky.
Peerless Electric Co., Warren, O.
Reed Unit-Fans, Inc., New Orleans, La.
Schwitzer-Cummins Co., Indianapolis, Ind.
●Torrington Mfg. Co., Torrington, Conn.

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Athey Co., Chicago, Ill.
Bostwick-Goodell Co., Norwalk, O.
Chicago Venetian Blind Co., Chicago, Ill.
Columbia Mills, Inc., Saginaw, Mich.
Higgin Mfg. Co., Newport, Ky.
Hough Co., Janesville, Wis.
Kane Mfg. Co., Kane, Pa.
Miller & Connell Co., Chicago, Ill.
Mitchell Moulding Co., Forest Park, Ill.
Patterson Shade Co., Indianapolis, Ind.
Schatz Venetian Blinds, Los Angeles, Cal.
Swedish Venetian Blind Co., New York, N. Y.
Warren Shade Co., Inc., Minneapolis, Minn.
Western Venetian Blind Co., New York, N. Y.
Yardley Screen & Weather Strip Corp., Columbus, O.

BLOCKS, PILLOW

Ahlberg Bearing Co., Chicago, Ill.
Air Controls, Inc., Cleveland, O.
Caldwell Co., W. E., Louisville, Ky.
Chain Belt Co., Milwaukee, Wis.
Chicago Die Casting Mfg. Co., Chicago, Ill.
Clizbe Bros. Mfg. Co., Plymouth, Ind.
Dick Co., Inc., R. & J., Passaic, N. J.
●Fafnir Bearing Co., New Britain, Conn. (Ball bearing).
●Frick Co., Waynesboro, Pa.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Medart Co., St. Louis, Mo.
Peerless Electric Co., Warren, O.
●Randall Graphite Products Corp., Chicago, Ill.
Royersford Foundry & Machine Co., Inc., Royersford, Pa.
Schwitzer-Cummins Co., Indianapolis, Ind.
SKF Industries, Inc., Philadelphia, Pa.
Shafer Bearing Corp., Chicago, Ill.
Smith, Inc., Winfield H., Springville, N. Y.
Sprout, Waldron & Co. Muncy Pa.
Viking Air Conditioning Corp. Cleveland, O.
Wood's Sons Co., T. B., Chambersburg, Pa.

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BLOWERS, PRESSURE

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Blower Corp., Detroit, Mich.
Bayley Blower Co., Milwaukee, Wis.
Beach-Russ Co., New York, N. Y.
●Buffalo Forge Co., Buffalo, N. Y.
Champion Blower & Forge Co., Lancaster, Pa.
●Clarage Fan Co., Kalamazoo, Mich.
Cleaver-Brooks Co., Milwaukee, Wis.
Dean Bros. Co., Indianapolis, Ind.
De Bothezat Div., American Machine & Metals Mfg. Corp., New York, N. Y.
Eclipse Fuel Engineering Co., Rockford, Ill.
Garden City Fan Co., Chicago, Ill.
●Ingersoll-Rand Co., New York, N. Y.
Janette Mfg. Co., Chicago, Ill.
Muncie Gear Wks., Muncie, Ind.
Roots-Connersville Blower Corp., Connersville, Ind.
Spencer Turbine Co., Hartford, Conn.
●Sturtevant Co., B. F., Boston, Mass.
Trimount Rotary Power Co., East Dedham, Mass.
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BLOW-OFF VALVES

See Valves, Blow-Off

BOILER CLEANING COMPOUNDS

See Compounds, Boiler Cleaning

BOILER COVERING

See Covering, Boiler and Tank

BOILER FEED PUMPS

See Pumps, Boiler Feed

BOILER FEEDERS

See Feeders, Water, Heating Boiler

BOILER SEALING COMPOUNDS

See Compounds, Boiler and Radiator Sealing

BOILER TUBES

See Tubes, Boiler

BOILERS, HEATING, CAST IRON, SECTIONAL

●American Radiator Co., New York, N. Y.
Bryan Steam Corp., Peru, Ind.
Bryant Heater Co., Cleveland, O.
●Burnham Boiler Corp., Irvington, N. Y.
●Crane Co., Chicago, Ill.
Farquhar Co., Ltd., A. B., York, Pa.
Hart & Crouse Co., Inc., Utica, N. Y.
Herbert Boiler Co., Chicago, Ill.
International Heater Co., Utica, N. Y.
Molby Boiler Co., New York, N. Y.
Mueller Furnace Co., L. J., Milwaukee, Wis.
National Radiator Corp., Johnstown, Pa.
Pierce Butler Radiator Corp., Syracuse, N. Y.
Prox Co., Frank, Terre Haute, Ind.
Reif-Rexoil, Inc., Buffalo, N. Y.
Richardson & Boynton Co., New York, N. Y.
Richmond Radiator Co., Inc., Uniontown, Pa.
Smith Co., H. B., Westfield, Mass.
Spencer Heater Co., Williamsport, Pa.
Thatcher Co., Newark, N. J.
United States Radiator Corp., Detroit, Mich.
Utica Radiator Corp., Utica, N. Y.
Weil-McLain Co., Chicago, Ill.
XXth Century H. & V. Co., Akron, O.

BOILERS, HEATING, STEEL, FIRE TUBE

Ames Iron Wks., Div. of Pierce Butler Radiator Corp., Oswego, N. Y.
Bass Foundry & Machine Co., Ft. Wayne, Ind.
Bigelow Co., New Haven, Conn.
Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
Brownell Co., Dayton, O.
●Burnham Boiler Corp., Irvington, N. Y.
Combination Boiler Co., Benton Harbor, Mich.
Combustion Engineering Co., Inc., New York, N. Y.
Dillon Steam Boiler Wks., Inc., D. M., Fitchburg, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
Erie City Iron Wks., Erie, Pa.
Farquhar Co, Ltd., A. B., York, Pa.
Farrar & Trefts, Buffalo, N. Y.
●Fitzgibbons Boiler Co., Inc., New York, N. Y.
Frost Mfg. Co., Galesburg, Ill.
Gardner, Bernard, New York, N. Y.
Heil Co., Milwaukee, Wis.
Herbert Boiler Co., Chicago, Ill.
Hodge Boiler Wks., East Boston, Mass.
International Boiler Wks. Co., East Stroudsburg, Pa.
International Engineering Wks., Inc., Framingham, Mass.
Johnston Bro., Inc., Ferrysburg, Mich.
Keeler Co., Williamsport, Pa.
●Kewanee Boiler Corp., Kewanee, Ill.
Koven & Bro., L. O., Jersey City, N. J.
Lookout Boiler & Mfg. Co., Chattanooga, Tenn.
Manitowoc Boiler Wks., Manitowoc, Wis.
McCormick & Co., J. H., Williamsport, Pa.
●Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Milwaukee Reliance Boiler Wks., Milwaukee, Wis.
Murray Iron Wks. Co., Burlington, Ia.
National Radiator Corp., Johnstown, Pa.
Orr & Sembower, Inc., Reading, Pa.
Pacific Steel Boiler Div., United States Radiator Corp., Detroit, Mich.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Pressure Oil Burners, Inc., York, Pa.
Reif-Rexoil, Inc., Buffalo, N. Y.
Smith Twin Tubular Boiler Co., Inc., Philadelphia, Pa.
Spencer Heater Co., Williamsport, Pa.
Titusville Iron Wks. Co., Titusville, Pa.
Union Iron Wks., Erie, Pa.
Vogt Machine Co., Henry, Louisville, Ky.
Waterfilm Boilers, Inc., Jersey City, N. J.
Wickes Boiler Co., Saginaw, Mich.
Wood Industries, Inc., Gar, Detroit, Mich.

BOILERS, HEATING, STEEL, WATER TUBE

Ames Iron Wks., Div. of Pierce Butler Radiator Corp., Oswego, N. Y.
Babcock & Wilcox Co., New York, N. Y.
Bass Foundry & Machine Co., Ft. Wayne, Ind.
Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
Bryan Steam Corp., Peru, Ind.
Combination Boiler Co., Benton Harbor, Mich.
Combustion Engineering Co., Inc., New York, N. Y.
Edge Moor Iron Wks., New York, N. Y.
Erie City Iron Wks., Erie, Pa.
Farquhar Co., Ltd., A. B., York, Pa.
Foster Wheeler Corp., New York, N. Y.
Gardner, Bernard, New York, N. Y.
International Boiler Wks. Co., East Stroudsburg, Pa.
International Engineering Wks., Inc., Framingham, Mass.
Joliet Heating Corp., Joliet, Ill.
Keeler Co., E., Williamsport, Pa.
●Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Murray Iron Wks. Co., Burlington Ia.
National Radiator Corp. Johnstown, Pa.
Orr & Sembower, Inc., Reading, Pa.
Riley Stoker Corp., Worcester, Mass.
Smith Twin Tubular Boiler Co., Inc., Philadelphia, Pa.
Spencer Heater Co., Williamsport, Pa.
Titusville Iron Wks. Co., Titusville, Pa.
United States Radiator Corp., Detroit, Mich.
Vogt Machine Co., Henry, Louisville, Ky.
Wickes Boiler Co., Saginaw, Mich.

BOLTS AND STUDS, FLANGE

Bethlehem Steel Co., Bethlehem, Pa.
●Crane Co., Chicago, Ill.
●Frick Co., Waynesboro, Pa.
Lamson & Sessions Co., Cleveland, O.
Multi-Seal Mfg. Co., Chicago, Ill.
●Republic Steel Corp., Cleveland, O.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.

BOLTS, EXPANSION

Chase Brass & Copper Co., Waterbury, Conn.
Chicago Expansion Bolt Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Diamond Expansion Bolt Co., Garwood, N. J.
Multi-Seal Mfg. Co., Chicago, Ill.
Paine Co., Chicago, Ill.
Rawplug Co., Inc., New York, N. Y.
●Republic Steel Corp., Cleveland, O.
Star Expansion Bolt Co., New York, N. Y.
U. S. Expansion Bolt Corp., New York, N. Y.

BOLTS, TOGGLE AND ANCHOR

Chicago Expansion Bolt Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Diamond Expansion Bolt Co., Garwood, N. J.
Grabler Mfg. Co., Cleveland, O.
Lamson & Sessions Co., Cleveland, O.
Multi-Seal Mfg. Co., Chicago, Ill.
Paine Co., Chicago, Ill.
Rawplug Co., Inc., New York, N. Y.
●Republic Steel Corp., Cleveland, O.
Star Expansion Bolt Co., New York, N. Y.
U. S. Expansion Bolt Corp., New York, N. Y.

BRAKES, SHEET METAL

Allsteel Press Co., Inc., Chicago, Ill.
Bertsch & Co., Cambridge City, Ind.
Cincinnati Shaper Co., Cincinnati, O.
Dreis & Krump Mfg. Co., Chicago, Ill.
Excelsior Tool & Machine Co., East St. Louis, Ill.
Heartley Machine & Tool Co., Toledo, O.
New Albany Machine Mfg. Co., New Albany, Ind.
Niagara Machine & Tool Wks., Buffalo, N. Y.
Ohl & Son, George A., Newark, N. J.
Peck, Stow & Wilcox Co., Southington, Conn.
Rafter Machine Co., Belleville, N. J.
Steelweld Machinery Co., Cleveland, O.
Whitney Metal Tool Co., Rockford, Ill.

BRASS PIPE

See Pipe, Brass and Copper

BRASS UNIONS

Unions, Brass

BRASS VALVES

See Valves, Gate and Valves, Globe

BRAZING TORCHES

See Torches, Brazing

BRONZE VALVES

See Valves, Gate and Valves, Globe

BUILDING INSULATION

See Insulation, Building

BURNERS, COAL, AUTOMATIC

See Stokers

BURNERS, GAS, COMMERCIAL AND INDUSTRIAL

Babcock & Wilcox Co., New York, N. Y.
Barber Gas Burner Co., Cleveland, O.
Bryan Steam Corp., Peru, Ind.
Bryant Heater Co., Cleveland, O.
Burdett Mfg. Co., Chicago, Ill.
Continental Stove Corp., Ironton, O.
Eclipse Fuel Engrg. Co., Rockford, Ill.
Engineer Co., New York, N. Y.
Hugo Mfg. Co., West Duluth, Minn.
●Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Mettler Co., Lee B., Los Angeles, Cal.
National Airoil Burner Co., Inc., Philadelphia, Pa.
National Machine Wks., Chicago, Ill.
North American Mfg. Co., Cleveland, O.
Payne Furnace & Supply Co., Beverly Hills, Cal.
Peabody Engrg. Corp., New York, N. Y.
R-S Products Corp., Philadelphia, Pa.
Reznor Mfg. Co., Mercer, Pa.
Roberts-Gordon Appliance Corp., Buffalo, N. Y.
Rotary Mfg. Co., Los Angeles, Cal.
Schutte & Koerting Co., Philadelphia, Pa.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Strong, Carlisle & Hammond Co., Cleveland, O.
Surface Combustion Corp., Toledo, O.

BURNERS, OIL, COMMERCIAL AND INDUSTRIAL

Ace Engineering Co., Chicago, Ill.
Babcock & Wilcox Co., New York, N. Y.
Bennett Corp., W. M., Omaha, Nebr.
Bryan Steam Corp., Peru, Ind.
Bethlehem Steel Co., Bethlehem, Pa.
Caloroil Burner Corp., Hartford, Conn.
Century Engrg. Corp., Cedar Rapids, Ia.
Chalmers Oil Burner Co., Minneapolis, Minn.
Chisholm Co., Allen E., Portland, Ore.
Combustion Engineering Co., Inc., New York, N. Y.
Connery Construction Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
d'Este Co., Julian, Charlestown, Mass.
Electrol, Inc., Clifton, N. J.
Engineer Co., New York, N. Y.
Enterprise Oil Burner Co., San Francisco, Cal.
French Rotary Oil Burner Co., Sebastopol, Cal.
Gilbert & Barker Mfg. Co., Springfield, Mass.
Hardinge Oil Burner Co., Chicago, Ill.
Heil Co., Milwaukee, Wis.
Johnson Co., S. T., Oakland, Cal.
Johnson Mfg. Co., Waterloo, Ia.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Kleen-Heet, Inc., Chicago, Ill.
Lammert & Mann Co., Chicago, Ill.
Littleford Bros., Cincinnati, O.
Mettler Co., Lee B., Los Angeles, Cal.
Milwaukee Reliance Boiler Wks., Milwaukee, Wis.
National Airoil Burner Co., Inc., Philadelphia, Pa.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
North American Mfg. Co., Cleveland, O.
Nu-Way Corp., Rock Island, Ill.
Peabody Engrg. Corp., New York, N. Y.
Petroleum Heat & Power Co., Stamford, Conn.
Pressure Oil Burners, Inc., York, Pa.
Ray Oil Burner Co., San Francisco, Cal.
Reif-Rexoil, Inc., Buffalo, N. Y.
Riley Stoker Corp., Worcester, Mass.
Rotary Mfg. Co., Los Angeles, Cal.
R-S Products Corp., Philadelphia, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Scott-Newcomb, Inc., St. Louis, Mo.
Silent Glow Oil Burner Corp., Hartford, Conn.
Simplex Oil Heating Corp., New York, N. Y.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Strong, Carlisle & Hammond Co., Cleveland, O.
Sundstrand Machine Tool Co., Rockford, Ill.
Todd Combustion Equipment, Inc., Brooklyn, N. Y.
Wayne Oil Burner Corp., Fort Wayne, Ind.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
Wood Industries, Inc., Gar, Detroit, Mich.
York Oil Burner Co., Inc., York, Pa.

CAST IRON PIPE

See Pipe, Cast Iron

CEMENT AND COMPOUNDS, PIPE JOINT

Acorn Refining Co., Cleveland, O.
Barber Co., Inc., Philadelphia, Pa.
Bell & Gossett Co., Chicago, Ill.
Blue Seal Chemical Co., Roselle Park, N. J.
Burnley Battery & Mfg. Co., Northeast, Pa.
Colebrooks Sons, Inc., W. H., Syracuse, N. Y.
Cooper Sanitary Co., Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Croll & Son, Jesse G., Philadelphia, Pa.
Desolvo Mfg. Co., Pittsburgh, Pa.
Detroit Graphite Co., Detroit, Mich.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.
●Grinnell Co., Inc., Providence, R. I.
Hercules Chemical Co., Inc., New York, N. Y.
Key Boiler Equipment Co., East St. Louis, Ill.
Northwestern Chemical Co., Marietta, O.
●Ric-wiL Co., Cleveland, O.
Sauereisen Cements Co., Sharpsburg, Pa.
Smooth-On Mfg. Co., Jersey City, N. J.
Star Products Co., New York, N. Y.

CEMENT, INSULATING

Acme Asbestos Covering & Flooring Co., Chicago, Ill.
Bird-Archer Co., New York, N. Y.
Carey Co., Philip, Lockland, Cincinnati, O.

Eagle-Picher Lead Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
General Insulating & Mfg. Co., Alexandria, Ind.
Johns-Manville, New York, N. Y.
Keasbey Co., Robert A., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Mineral Felt Co., Toledo, O.
Mineral Insulation Co., Chicago Ridge, Ill.
Mortell Co., J. W., Chicago, Ill. (Adhesive)
●Owens-Illinois Glass Co., Toledo, O.
Refractory & Insulation Corp., New York, N. Y.
Ruberoid Co., New York, N. Y.
Sall Mountain Co., Chicago, Ill.
Sauereisen Cements Co., Sharpsburg, Pa.
Self-Vulcanizing Rubber Co., Inc., Chicago, Ill. (Rubber)
Smith & Kanzler, Inc., Elizabeth, N. J.
Standard Lime & Stone Co., Baltimore, Md.
Therminsul Corp., Kalamazoo, Mich.
Union Fibre Co., Inc., Winona, Minn.

CENTRIFUGAL PUMPS

See Pumps, Centrifugal

CHAIN DRIVES

See Drives, Chain

CHECK VALVES

See Valves, Check

CIRCULATORS, FOR HOT WATER HEATING SYSTEMS

Automatic Stoker Corp., Milwaukee, Wis.
Bell & Gosset Co., Chicago, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
Hoosick Engineering Co., Inc., Hoosick Falls, N. Y.
Janette Mfg. Co., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Penberthy Injector Co., Detroit, Mich.
Sterling Engineering Co., Milwaukee, Wis.
Stevens-Root Co., Chicago, Ill.
Taco Heaters, Inc., Brooklyn, N. Y.
Thrush & Co., H. A., Peru, Ind.
Watts Regulator Co., Lawrence, Mass.
Weil Pump Co., Chicago, Ill.
Yeomans Bros Co., Chicago, Ill.

CLAMPS, BEAM, PIPE HANGING

Beaton & Cadwell Mfg. Co., New Britain, Conn.
Chicago Nipple Mfg. Co., Chicago, Ill.
Carpenter & Paterson, Inc., East Boston, Mass.
●Crane Co., Chicago, Ill.
Crawford Co., Chicago, Ill.
Farley Sleeve & Hanger Co., Cleveland, O.
●Frick Co., Waynesboro, Pa.
Globe Machine & Stamping Co., Cleveland, O.
Grabler Mfg. Co., Cleveland, O.
●Grinnell Co., Inc., Providence, R. I.
Jarecki Mfg. Co., Erie, Pa.
Malleable Iron Fittings Co., Branford, Conn.
Paine Co., Chicago, Ill.
Pittsburgh Valve & Fittings Corp., Barberton, O.
●Walworth Co., New York, N. Y.

CLAMPS, PIPE REPAIR

Blair Products Co., New York, N. Y.
Chelsea Metal Stamping Co., New York, N. Y.
Dresser Mfg. Co., S. R., Bradford, Pa.
Jarecki Mfg. Co., Erie, Pa.
Skinner Co., M. B., South Bend, Ind.

COLLECTORS, DUST

●Airtherm Mfg. Co., St. Louis, Mo.
Allen Billmyre Corp., South Norwalk, Conn.
●American Air Filter Co., Louisville, Ky.
American Blower Corp., Detroit, Mich.
American Foundry Equipment Co., Mishawaka, Ind.
Blower Application Co., Milwaukee, Wis.
Bubar, Hudson H., New York, N. Y.
●Buffalo Forge Co., Buffalo, N. Y.
Columbian Steel Tank Co., Kansas City, Mo.
Dracco Corp., Cleveland, O.
Falstrom Co., Passaic, N. J.
Goethel Co., Alfred C., Milwaukee, Wis.
Goethel Sheet Metal Wks., Alfred, Milwaukee, Wis.
Grand Rapids Blow Pipe & Dust Arrester Co., Grand Rapids, Mich.
Kirk & Blum Mfg. Co., Cincinnati, O.
Knickerbocker Co., Jackson, Mich.
Lehigh Fan & Blower Co., Allentown, Pa.
New York Blower Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Northern Blower Co., Cleveland, O.
Pangborn Corp., Hagerstown, Md.
St. Louis Blow Pipe & Heater Co., St. Louis, Mo.
Schneible Co., Claude B., Chicago, Ill.
Sly Mfg. Co., W. W., Cleveland, O.
Sprout Waldron & Co., Muncy, Pa.
Strandwitz & Co., Inc., Camden, N. J.
●Sturtevant Co., B. F., Boston, Mass.

COMBUSTION RECORDERS

See Recorders, Combustion

COMFORT AIR CONDITIONERS

See Unit Air Conditioners, Comfort

COMPOUNDS, BOILER, CLEANING

American Teksag Products, Inc., Mount Vernon, N. Y.
Aquatic Chemical & Metallurgical Engineers, New York, N. Y.
Blue Seal Chemical Co., Roselle Park, N. J.
Chicago Specialty Mfg. Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Dissolene Corp., Hempstead, N. Y.
Dole Valve Co., Chicago, Ill.
Ferro-Nil Corp., New York, N. Y.
Haering & Co., Inc., D. W., Chicago, Ill.
Hercules Chemical Co., Inc., New York, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Radiator Specialty Co., Charlotte, N. C.
Star Products Co., New York, N. Y.
Vinco Co., Inc., New York, N. Y.
X Laboratories, New York, N. Y.

COMPOUNDS, BOILER AND RADIATOR SEALING

Blue Seal Chemical Co., Roselle Park, N. J.
Chicago Specialty Mfg. Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Croll & Son, Jesse G., Philadelphia, Pa.
Desolvo Mfg. Co., Pittsburgh, Pa.
Dole Valve Co., Chicago, Ill.
Hercules Chemical Co., Inc., New York, N. Y.
Northwestern Chemical Co., Marietta, O.
Radiator Specialty Co., Charlotte, N. C.
Star Products Co., New York, N. Y.
X Laboratories, New York, N. Y.

COMPRESSOR BASES

See Bases, Vibration Isolating

COMPRESSORS, AIR

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
●Binks Mfg. Co., Chicago, Ill.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., New York, N. Y.
●Curtis Refrigerating Machine Co., St. Louis, Mo.
Dayton Air Compressor Co., Dayton, O.
●Fedders Mfg. Co., Buffalo, N. Y.
Fuller Co., Catasauqua, Pa.
Gardner-Denver Co., Quincy, Ill.
Hobart Bros. Co., Troy, O.
●Ingersoll-Rand, New York, N. Y.
Janette Mfg. Co., Chicago, Ill.
Kellogg Compressor & Mfg. Corp., Rochester, N. Y.
Kinney Mfg. Co., Boston, Mass.
Metals Coating Co. of America, Philadelphia, Pa.
●Mills Novelty Co., Chicago, Ill.
●Nash Engineering Co., South Norwalk, Conn.
Norwalk Co., Inc., S. Norwalk, Conn.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Plummer Spray Equipment Co., Napoleon, O.
Schramm, Inc., West Chester, Pa.
Spencer Turbine Co., Hartford, Conn.
Trimount Rotary Power Co., East Dedham, Mass.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

COMPRESSORS, REFRIGERATING, CENTRIFUGAL

●Carrier Corp., Newark, N. J. (Carrene)
DeLaval Steam Turbine o., Trenton, N. J. (Water vapor)
●Ingersoll-Rand, New York, N. Y. (Water vapor)

COMPRESSORS, REFRIGERATING, RECIPROCATING

Airtemp, Inc., Detroit, Mich.
Advanced Engineering Co., Philadelphia, Pa.
●Baker Ice Machine Co., Inc., Omaha, Nebr. ("Freon," methyl chloride, ammonia).
Brunner Mfg. Co., Utica, N. Y. (Methyl chloride, "Freon," sulphur dioxide).
Builders Iron Foundry, Providence, R. I.
●Carbondale Machine Corp., Harrison, N. J. ("Freon," ammonia, carbon dioxide, methyl chloride).
●Carrier Corp., Newark, N. J. (Ammonia, "Freon," methyl chloride, carbon dioxide).
Copeland Refrigeration Corp., Mt. Clemens, Mich.
Corozone Air Conditioning Corp., Cleveland, O.
●Curtis Refrigerating Machine Co., St. Louis, Mo.
De La Vergne Engine Co., Philadelphia, Pa. (Ammonia, "Freon").
Delco Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O. ("Freon").
●Fairbanks, Morse & Co., Chicago, Ill.
●Frick Co., Waynesboro, Pa. (Ammonia, carbon dioxide, methyl chloride, "Freon").
General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
Hardy Mfg. Co., Inc., Dayton, O. (Sulphur dioxide, methyl chloride).
Howe Ice Machine Co., Chicago, Ill. ("Freon," ammonia, methyl chloride).
Kauffman Air Conditioning Corp., St. Louis, Mo.
●Kelvinator Corp., Detroit, Mich.
Merchant & Evans Co., Philadelphia, Pa. ("Freon," methyl chloride, sulphur dioxide).

●Mills Novelty Co., Chicago, Ill.
Nash Refrigeration Co., Inc., Newark, N. J.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
Norwalk Co., Inc., S. Norwalk, Conn. (Carbon dioxide).
Phoenix Ice Machine Co., Cleveland, O.
Reliance Refrigerating Machine Co., Chicago, Ill. ("Freon," methyl, ammonia).
Russell Electric Co., Chicago, Ill.
●Servel Inc., Commercial Refrigeration Division, Evansville, Ind. ("Freon," methyl chloride).
Starr Piano Co., Richmond, Ind.
Thermal Units Mfg. Co., Chicago, Ill. ("Freon").
Triumph Ice Machine Co., Cincinnati, O. (Ammonia).
Uniflow Mfg. Co., Erie, Pa. (Sulphur dioxide, methyl chloride).
Universal Cooler Corp., Detroit, Mich. (Methyl chloride, "Freon").
●Vilter Mfg. Co., Milwaukee, Wis. ("Freon," ammonia).
Vogt Machine Co., Henry, Louisville, Ky. (Ammonia).
●Westinghouse Electric & Mfg. Co., Mansfield, O.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill. ("Freon," methyl chloride).
Wittenmeier Machinery Co., Chicago, Ill. (Carbon dioxide).
XL Refrigerating Co., Chicago, Ill. (Ammonia, methyl chloride).
●York Ice Machinery Corp., York, Pa. (Carbon dioxide, ammonia, "Freon").

COMPRESSORS, REFRIGERATING, STEAM JET

American Blower Corp., Detroit, Mich.
●Carbondale Machine Corp., Harrison, N. J.
●Carrier Corp., Newark, N. J.
Croll-Reynolds Engrg. Co., Inc., New York, N. Y.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., New York, N. Y.
Graham Mfg. Co., Inc., Buffalo, N. Y.
●Ingersoll-Rand, New York, N. Y.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

CONDENSATION METERS

See Meters, Condensation

CONDENSATION PUMPS

See Pumps, Condensation

CONDENSERS, EVAPORATIVE

●Baker Ice Machine Co., Inc., Omaha, Nebr.
●Buffalo Forge Co., Buffalo, N. Y.
●Carbondale Machine Corp., Harrison, N. J.
Carraway-Byrd Engineering Co., Dallas, Tex.
●Carrier Corp., Newark, N. J.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
●Frick Co., Waynesboro, Pa.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
●Vilter Mfg. Co., Milwaukee, Wis.
XL Refrigerating Co., Chicago, Ill.
●York Ice Machinery Corp., York, Pa.

CONDENSERS, REFRIGERATING

Acme Industries, Inc., Jackson, Mich.
Advanced Engineering Co., Philadelphia, Pa.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Bush Mfg. Co., Hartford, Conn.
●Carbondale Machine Corp., Harrison, N. J.
●Carrier Corp., Newark, N. J.
De La Vergne Engine Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
●Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.
General Refrigeration Sales Co., Beloit, Wis.
Howe Ice Machine Co., Chicago, Ill.
●Kelvinator Corp., Detroit, Mich.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Nash Refrigeration Co., Inc., Newark, N. J.
Ohio Pipe Bending & Machine Co., Cleveland, O.
Reliance Refrigerating Machine Co., Chicago, Ill.
Roessing Mfg. Co., Pittsburgh, Pa.
Rome-Turney Radiator Co., Rome, N. Y.
Struthers-Wells-Titusville Co., Warren, Pa.
Thermal Units Mfg. Co., Chicago, Ill.
Trenton Auto Radiator Wks., Trenton, N. J.
Triumph Ice Machine Co., Cincinnati, O.
●Unit Heater & Cooler Co., Wausau, Wis.
●Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
●Westinghouse Electric & Mfg. Co., Mansfield, O.
Wittenmeier Machinery Co., Chicago, Ill.
XL Refrigerating Co., Chicago, Ill.
Yates-American Machine Co., Beloit, Wis.
●York Ice Machinery Corp., York, Pa.

CONDENSERS, STEAM

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Chicago Pneumatic Tool Co., New York, N. Y.
Columbian Steel Tank Co., Kansas City, Mo.
Croll-Reynolds Engineering Co., Inc., New York, N. Y.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., New York, N. Y.
Graham Mfg. Co., Buffalo, N. Y.
Murray Iron Wks. Co., Burlington, Ia.
National Pipe Bending Co., New Haven, Conn.
Rome-Turney Radiator Co., Rome, N. Y.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
●Unit Heater & Cooler Co., Wausau, Wis.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.

CONDENSING UNITS

See Compressors

CONDUIT, UNDERGROUND PIPING

●American District Steam Co., North Tonawanda, N. Y.
Johns-Manville, New York, N. Y.
●Porter & Co., Inc., H. W., Newark, N. J.
●Ric-wiL Co., Cleveland, O.
Underground Steam Construction Co., Boston, Mass.
Wyckoff & Son Co., A., Elmira, N. Y.

CONTROLLERS AND STARTERS, MOTOR

●Allen-Bradley Co., Milwaukee, Wis.
●Clark Controller Co., Cleveland, O.
Cooper Co., Clark, Philadelphia, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
Durakool, Inc., Elkhart, Ind.
Electric Controller & Mfg. Co., Cleveland, O.
Electric Machinery Co., Minneapolis, Minn.
General Electric Co., Schenectady, N. Y.
Hart Mfg. Co., Hartford, Conn.
Monitor Controller Co., Baltimore, Md.
Square D Co., Detroit, Mich.
Trumbull Electric Mfg. Co., Plainville, Conn.
Ward Leonard Electric Co., Mt. Vernon, N. Y.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CONTROLS, HUMIDITY AND TEMPERATURE

See Humidistats, Recorder-Controllers, Thermostats

CONTROLS, REFRIGERATION

See Valves, Refrigeration

CONVECTORS

See Radiation, Convection Type

COOLING SURFACE

See Surface, Cooling

COOLING TOWERS

See Towers, Cooling

COOLING UNITS

See Unit Air Conditioners, Cooling and Dehumidifying

COPPER PIPE

See Pipe, Brass and Copper

COPPER SHEETS

See Sheets, Copper

COPPER TUBE FITTINGS

See Fittings, Copper Tube

COPPER TUBING

See Tubing, Copper

COUPLINGS, FLEXIBLE, POWER TRANSMISSION

Ajax Flexible Coupling Co., Westfield, N. Y.
●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Flexible Coupling Co., Erie, Pa.
Bartlett Hayward Co., Baltimore, Md.
Blood Brothers, Allegan, Mich. (Universal joints)
Bordo Co., Inc., L. J., Glenside, Pa.
Boston Gear Wks., Inc., North Quincy, Mass.
Caldwell Co., W. E., Louisville, Ky.
Certified Flexible Couplings, Inc., New York, N. Y.
Chicago Die Casting Mfg. Co., Chicago, Ill.
●Clark Controller Co., Cleveland, O.
Continental Diamond Fibre Co., Newark, Del.
Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.
De Laval Steam Turbine Co., Trenton, N. J.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Dick Co., Inc., R. & J., Passaic, N. J.
Flexo Supply Co., Inc., St. Louis, Mo.
Guardian Utilities Co., Chicago, Ill.
Lewis & Co., Inc., Chas. S., St. Louis, Mo.
Link-Belt Co., Chicago, Ill.
Lovejoy Tool Wks., Chicago, Ill.
Medart Co., St. Louis, Mo.
Moran Flexible Steam Joint Co., Louisville, Ky.
Morse Chain Co., Ithaca, N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Poole Foundry & Machine Co., Baltimore, Md.
Smith, Inc., Winfield H., Springville, N. Y.
Strong-Scott Mfg. Co., Minneapolis, Minn.
Waldron Corp., John, New Brunswick, N. J.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Whitney Mfg. Co., Hartford, Conn.
Wood's Sons Co., T. B., Chambersburg, Pa.

COUPLINGS, PIPE

Barco Mfg. Co., Chicago, Ill. (Flexible).
Champion Machine & Forging Co., Cleveland, O.
Chase Brass & Copper Co., Waterbury, Conn.
Cohoes Rolling Mill Co., Cohoes, N. Y.
●Crane Co., Chicago, Ill.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
Dresser Mfg. Co., S. R., Bradford, Pa.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
Grabler Mfg. Co., Cleveland, O.
●Grinnell Co., Inc., Providence, R. I.
Harrisburg Steel Corp., Harrisburg, Pa.
Hasco Valve & Machine Co., Milwaukee, Wis.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
King Union Co., Inc., Hillsgrove, R. I.
Malleable Iron Fittings Co., Branford, Conn.
●National Tube Co., Pittsburgh, Pa.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Ravena Iron Co., Ravena, N. Y. (Cast iron).
Reading Iron Co., Philadelphia, Pa.
●Republic Steel Corp., Cleveland, O.
Semler Co., Jeannette, Pa.
Standard Auto-Tite Joint Co., Pittsburgh, Pa.
Taylor Forge & Pipe Wks., Chicago, Ill.
Union Metal Wks., Inc., Chelsea, Mass.
Victaulic Co. of America, New York, N. Y.
●Walworth Co., New York, N. Y.
Weatherhead Co., Cleveland, O.
●Wheeling Steel Corp., Wheeling, W. Va.
●Youngstown Sheet & Tube Co., Youngstown, O.

COVERING, BOILER AND TANK

Acme Asbestos Covering & Flooring Co., Chicago, Ill.
Alfol Insulation Co., Inc., New York, N. Y.
●Armstrong Cork Products Co., Lancaster, Pa.
Carey Co., Philip, Lockland, Cincinnati, O.
Eagle-Picher Lead Co., Cincinnati, O.
General Insulating & Mfg. Co., Alexandria, Ind.
International Vermiculite Co., Springfield, Ill.
Jamar Co., Walker, Duluth, Minn.
Johns-Manville, New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Mineral Felt Co., Toledo, O.
●Owens-Illinois Glass Co., Toledo, O. (Blanket)
Ruberoid Co., New York, N. Y. (Asbestos, magnesia)
Sall Mountain Co., Chicago, Ill.
Smith & Kanzler, Inc., Elizabeth, N. J.
Standard Asbestos Mfg. Co., Chicago, Ill.
Therminsul Corp., Kalamazoo, Mich.
Union Fibre Co., Inc., Winona, Minn.

COVERING, PIPE

Acme Asbestos Covering & Flooring Co., Chicago, Ill.
Alfol Insulation Co., Inc., New York, N. Y.
●American District Steam Co., North Tonawanda, N. Y. (Underground).
●Armstrong Cork Products Co., Lancaster, Pa. (Cork).
Carey Co., Philip, Lockland, Cincinnati, O. (Asbestos, magnesia).
●Cork Import Corp., New York., N. Y.
●Cork Insulation Co., New York, N. Y.
●Crane Co., Chicago, Ill. (Asbestos).
Eagle-Picher Lead Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
General Insulating & Mfg. Co., Alexandria, Ind. (Moulded).
International Vermiculite Co., Springfield, Ill. (Vermiculite).
Jamar Co., Walker, Duluth, Minn.
Johns-Manville, New York, N. Y. (Asbestos, magnesia, rock cork).
Keasbey Co., Robert A., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa. (Asbestos, magnesia).
Miller Rubber Co., Inc., Akron, O.
Mineral Felt Co., Toledo, O.
●Mundet Cork Corp., New York, N. Y. (Cork).
Norristown Magnesia & Asbestos Co., Norristown, Pa. (Asbestos, magnesia).
●Owens-Illinois Glass Co., Toledo, O. (Glass wool).
●Porter & Co., Inc., H. W., Newark, N. J. (Underground).
●Ric-wiL Co., Cleveland, O. (Underground).
Ruberoid Co., New York, N. Y. (Asbestos, magnesia).
Sall Mountain Co., Chicago, Ill. (Asbestos).
Self-Vulcanizing Rubber Co., Inc., Chicago, Ill. (Rubber).
Smith & Kanzler, Inc., Elizabeth, N. J. (Asbestos air cell, wool felt and hair felt).
Standard Asbestos Mfg. Co., Chicago, Ill.
Standard Lime & Stone Co., Baltimore, Md. (Rockwool).
Therminsul Corp., Kalamazoo, Mich.
Union Fibre Co., Inc., Winona, Minn.
United Cork Companies, Lyndhurst, N. J.
Wyckoff & Son Co., A., Elmira, N. Y. (Wood).

CUTTERS, PIPE AND TUBING

American Pipe Tool Co., Chicago, Ill.
Armstrong Bros. Tool Co., Chicago, Ill.
Armstrong Mfg. Co., Bridgeport, Conn.
Barnes Tool Co., New Haven, Conn.
Beaver Pipe Tools, Inc., Warren, O.
●Crane Co., Chicago, Ill.
Erie Tool Wks., Erie, Pa.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hollands Mfg. Co., Erie, Pa.
Imperial Brass Mfg. Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Nye Tool & Machine Wks., Chicago, Ill.
Parker Appliance Co., Cleveland, O.
●Ridge Tool Co., Elyria, O.
Toledo Pipe Threading Machine Co., Toledo, O.
●Trimont Mfg. Co., Boston, Mass.
Vanderman Mfg. Co., Willimantic, Conn.
Weatherhead Co., Cleveland, O.

DAMPER OPERATORS

See Operators, Damper

DAMPER QUADRANTS

See Quadrants, Damper

DAMPERS, DUCT

American Foundry & Furnace Co., Bloomington, Ill.
American Warming & Ventilating Co., Toledo, O.
Brown, Wm. P., Springfield, Mass.
Burt Mfg. Co., Akron, O.
Chicago Metal Mfg. Co., Chicago, Ill.
Elgo Shutter & Mfg. Co., Detroit, Mich.
Hampden Cornice Wks., Inc., Springfield, Mass.
Hart & Cooley Mfg. Co., Chicago, Ill.
●Henry Furnace & Foundry Co., Cleveland, O.
Iona Ventilator Co., Inc., Philadelphia, Pa.
Jordan & Co., Paul R., Indianapolis, Ind.
King Ventilating Co., Owatonna, Minn.
Lennox Furnace Co., Marshalltown, Ia.
Strandwitz & Co., Inc., Camden, N. J.
●Tuttle & Bailey, Inc., New Britain, Conn.
United States Register Co., Battle Creek, Mich.

DAMPERS, REMOTE CONTROLLED

●Barber-Colman Co., Rockford, Ill.
●Carrier Corp., Newark, N. J.
●Johnson Service Co., Milwaukee, Wis.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
●Powers Regulator Co., Chicago, Ill.

DEAERATORS

Centrifix Corp., Cleveland, O.
Cochrane Corp., Philadelphia, Pa.
Croll-Reynolds Engrg. Co., Inc., New York, N. Y.
Elliott Co., Jeannette, Pa.
Hagan Corp., Pittsburgh, Pa.
Hoppes Mfg. Co., Springfield, O.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.

DEEP WELL PUMPS

See Pumps, Deep Well

DEHUMIDIFIERS, ADSORPTION

American Injector Co., Detroit, Mich.
Bryant Heater Co., Cleveland, O. (Silica gel)
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.
Research Corp., New York, N. Y.
Russell Electric Co., Chicago, Ill.
Somers, Inc., H. J., Detroit, Mich.
Surface Combustion Corp., Toledo, O.

DEHUMIDIFYING UNITS

See Unit Air Conditioners, Cooling and Dehumidifying

DETECTORS, LEAK, REFRIGERANT

Bernz Co., Inc., Otto, Rochester, N. Y.
Clayton & Lambert Mfg. Co., Detroit, Mich.
Hull Mfg. Co., Hagerstown, Md.
●Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.
Turner Brass Wks., Sycamore, Ill.

DIAPHRAGM VALVES

See Valves, Diaphragm

DIFFUSERS, AIR

See Grilles

DOORS AND PANELS, ACCESS

American Foundry & Furnace Co., Bloomington, Ill.
●Auer Register Co., Cleveland, O.
●Clarage Fan Co., Kalamazoo, Mich.
Higgin Mfg. Co., Newport, Ky.
Kane Mfg. Co., Kane, Pa.
Kirk & Blum Mfg. Co., Cincinnati, O.
Rock Island Register Co., Rock Island, Ill.
●Sturtevant Co., B. F., Boston, Mass.
●Tuttle & Bailey, Inc., New Britain, Conn.
Walsh-Spencer Co., Boston, Mass.
Way Panel Loctor Co., Wollaston, Mass.

DOORS, REVOLVING

Atchison Revolving Door Co., Independence, Kans.
General Bronze Corp., Long Island City, N. Y.
Revolving Doors, Inc., New York, N. Y.
Newman Brothers, Inc., Cincinnati, O.
Van Kannel Revolving Door Co., New York, N. Y.

DRAFT GAGES
See Gages, Indicating, Draft

DRAFT RECORDERS
See Recorders, Draft

DRAFT REGULATORS
See Regulators, Draft

DRILLS, PORTABLE, ELECTRIC
Black & Decker Mfg. Co., Towson, Md.
Chicago Pneumatic Tool Co., New York, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Independent Pneumatic Tool Co., Chicago, Ill.
Millers Falls Co., Greenfield, Mass.
Stanley Wks., New Britain, Conn.
Starbuck & Sons, Inc., R. M., Hartford, Conn. (Rotary pipe hole saws).
U. S. Electrical Tool Co., Cincinnati, O.
Skilsaw, Inc., Chicago, Ill.

DRIVES, CHAIN
Boston Gear Works, Inc., North Quincy, Mass.
Caldwell Co., W. E., Louisville, Ky.
Chain Belt Co., Milwaukee, Wis.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Medart Co., St. Louis, Mo.
Morse Chain Co., Ithaca, N. Y.
Ramsey Chain Co., Inc., Albany, N. Y.
Whitney Mfg. Co., Hartford, Conn.

DRIVES, FLAT BELT
(See also Belting, Leather and Belting, Rubber)
Alexander Bros., Philadelphia, Pa.
American Pulley Co., Philadelphia, Pa.
Chicago Belting Co., Chicago, Ill.
Chicago Die Casting Mfg. Co., Chicago, Ill.
Continental Rubber Wks., Erie, Pa.
Dick Co., Inc., R & J., Passaic, N. J.
Medart Co., St. Louis, Mo.
Ohio Valley Pulley Works Div., Browning Mfg. Co., Inc., Maysville, Ky.
Rockwood Mfg. Co., Indianapolis, Ind.
Smith, Inc., Winfield H., Springville, N. Y.
Wood's Sons Co., T. B., Chambersburg, Pa.

DRIVES, V BELT
●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Pulley Co., Philadelphia, Pa.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Boston Gear Wks., Inc., North Quincy, Mass.
Chicago Die Casting Mfg. Co., Chicago, Ill.
Continental Rubber Wks., Erie, Pa.
Dayton Rubber Mfg. Co., Dayton, O.
Dick Co., Inc., R. & J., Passaic, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
●Frick Co., Waynesboro, Pa.
Gates Rubber Co., Denver, Colo.
Horton Mfg. Co., Minneapolis, Minn.
Jones Foundry Machine Co., W. A., Chicago, Ill.
Medart Co., St. Louis, Mo.
Ohio Valley Pulley Works Div., Browning Mfg. Co., Inc., Maysville, Ky.
Pyott Foundry & Machine Co., Chicago, Ill.
Rockwood Mfg. Co., Indianapolis, Ind.
Smith, Inc., Winfield H., Springville, N. Y.
Wood's Sons Co., T. B., Chambersburg, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.

DUAL THERMOSTATS
See Thermostats, Two Temperature or Dual

DUCT DAMPERS
See Dampers, Duct

DUCT HEATERS
See Heaters, Duct, Electric

DUCT INSULATION
See Insulation, Duct

DUCT THERMOSTATS
See Thermostats, Duct Type

DUCTS AND DUCT FITTINGS, PREFABRICATED
Acer & Whedon, Medina, N. Y.
Acme Tin Plate & Roofing Supply Co., Philadelphia, Pa.
Chicago Metal Mfg. Co., Chicago, Ill.
Cincinnati Sheet Metal & Roofing Co., Cincinnati, O.
Excelsior Steel Furnace Co., Chicago, Ill.
●Henry Furnace & Foundry Co., Cleveland, O.
Lamneck Products, Inc., Columbus, O.
Meyer & Bro. Co., F., Peoria, Ill.
Reynolds Corp., New York, N. Y.
Robertson Co. H. H., Pittsburgh, Pa.
Zonolite Corp., Detroit, Mich.

DUST COLLECTORS
See Collectors, Dust

EJECTORS, SEWAGE
●American Steam Pump Co., Battle Creek, Mich.
Chicago Pump Co., Chicago, Ill.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Nash Engineering Co., South Norwalk, Conn.
Quimby Pump Co., Inc., Newark, N. J.
Taber Pump Co., Buffalo, N. Y.
Weil Pump Co., Chicago, Ill.
Yeomans Bros Co., Chicago, Ill.

ELECTRIC DRILLS
See Drills, Portable, Electric

ELECTRIC MOTORS
See Motors, Electric

ELECTRIC UNIT HEATERS
See Heaters, Unit, Electric

ELECTRODES, ARC WELDING
Air Reduction Sales Co., New York, N. Y.
American Chain Co., Inc., Bridgeport, Conn.
American Steel & Wire Co., Chicago, Ill.
Commonwealth Mfg. Corp., Cincinnati, O.
General Electric Co., Schenectady, N. Y.
Gulf States Steel Co., Birmingham, Ala.
Keasbey & Mattison Co., Ambler, Pa.
Lincoln Electric Co., Cleveland, O.
Maurath, Inc., Cleveland, O.
Page Steel & Wire Division of American Chain Co., Inc., Monessen, Pa.
Roebling's Sons, John A., Trenton, N. J.
Seneca Wire & Mfg. Co., Fostoria, O.
Una Welding, Inc., E. Cleveland, O.
Universal Power Corp., Cleveland, O.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilson Welder & Metals Co., Inc., North Bergen, N. J.

ELIMINATORS, AIR, FOR HEATING SYSTEMS
●American Radiator Co., New York, N. Y.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
●Dunham Co., C. A., Chicago, Ill.
Gorton Heating Corp., Cranford, N. J.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Maid-O-Mist, Inc., Chicago, Ill.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
●Sarco Co., Inc., New York, N. Y.
Sterling Engineering Co., Milwaukee, Wis.
●Trane Co., La Crosse, Wis.
Vapor Heating Co., New York, N. Y.
Watson & McDaniel Co., Philadelphia, Pa.
●Webster & Co., Warren, Camden, N. J.

ENGINES, GAS, FOR FAN, PUMP AND COMPRESSOR DRIVES
Chicago Pneumatic Tool Co., New York, N. Y.
Continental Motors Corp., Detroit, Mich.
Universal Motor Co., Oshkosh, Wis.
U. S. Motors Corp., Oshkosh, Wis.
Waukesha Motor Co., Waukesha, Wis.
●Worthington Pump & Machinery Corp., Harrison, N. J.

ENGINES, STEAM, FOR FAN, PUMP AND COMPRESSOR DRIVES
Ames Iron Wks., Div. of Pierce Butler Radiator Corp., Oswego, N. Y.
Elliott Co., Jeannette, Pa.
●Frick Co., Waynesboro, Pa.
Harrisburg Fdry. & Mach. Co., Inc., Harrisburg, Pa.
Leffel & Co., James, Springfield, O.
Morris Machine Wks., Baldwinsville, N. Y.
Murray Iron Wks., Co., Burlington, Ia.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Skinner Engine Co., Erie, Pa.
●Sturtevant Co, B. F., Boston, Mass.
Troy Engine & Machine Co., Troy, Pa.
●Vilter Mfg. Co., Milwaukee, Wis.
●Worthington Pump & Machinery Corp., Harrison, N. J.

EVAPORATIVE CONDENSERS
See Condensers, Evaporative

EXCHANGERS, HEAT
Acme Industries, Inc., Jackson, Mich.
●Baker Ice Machine Co., Omaha, Nebr.
●Carbondale Machine Corp., Harrison, N. J.
Cochrane Corp., Philadelphia, Pa.
Davis Engineering Corp., Elizabeth, N. J.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill.
Filtrine Mfg. Co., Brooklyn, N. Y.
Frank Engineering Co., New York, N. Y.
●Frick Co., Waynesboro, Pa.
General Refrigeration Sales Co., Beloit, Wis.
Graham Mfg. Co., Buffalo, N. Y.
Griscom-Russell Co., New York, N. Y.
Heat Transfer Co., Huntington, Ind.
Howard Iron Wks. & Alberger Heater Co., Buffalo, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Larkin Refrigerating Corp., Atlanta, Ga.
McCord Radiator & Mfg. Co., Detroit, Mich.
National Pipe Bending Co., New Haven, Conn.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Rome-Turney Radiator Co., Rome, N. Y.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.

Sims Co., Erie, Pa.
Super Radiator Corp., Minneapolis, Minn.
●Vilter Mfg. Co, Milwaukee, Wis.
●Westinghouse Electric & Mfg. Co., Mansfield, O.
Whitlock Coil Pipe Co., Hartford, Conn.
●York Ice Machinery Corp., York, Pa.

EXPANSION BENDS

See Bends, Expansion

EXPANSION BOLTS

See Bolts, Expansion

EXPANSION JOINTS

See Joints, Pipe, Expansion

EXPANSION VALVES

See Valves, Refrigerating

FAN BASES

See Bases, Vibration Isolating

FAN BLADES

See Blades, Fan

FANS, CENTRIFUGAL

Advance Fan & Blower Co., Detroit, Mich.
Air Controls, Inc., Cleveland, O.
Air Devices Corp., Chicago, Ill.
Allen Billmyre Corp., New York, N. Y.
American Blower Corp., Detroit, Mich.
Ames Co., W. R., San Francisco, Cal.
Arex Co., Chicago, Ill.
●Autovent Fan & Blower Co., Chicago, Ill.
Ballantyne Co., Omaha, Nebr.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
Blower Application Co., Milwaukee, Wis.
●Buffalo Forge Co., Buffalo, N. Y.
Campbell Heating Co., Des Moines, Ia.
Campbell Heating Co., E. K., Kansas City, Mo.
Champion Blower & Forge Co., Lancaster, Pa.
●Clarage Fan Co., Kalamazoo, Mich.
Columbus Heating & Ventilating Co., Columbus, O.
Coppus Engineering Corp., Worcester, Mass.
De Bothezat Div., American Machine & Metals Mfg. Corp., New York, N. Y.
Dixie Mfg. Co., Inc., Baltimore, Md.
Duriron Co., Inc., Dayton, O. (Acid resisting).
Economy Electric Mfg. Co., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
Evry-Use Products, Inc., New York, N. Y.
Garden City Fan Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Johnson Fan & Blower Corp., Chicago, Ill.
Jordan & Co., Paul R., Indianapolis, Ind.
Lehigh Fan & Blower Co., Allentown, Pa.
Mechanical Air, Little Rock, Ark.
Montag Stove & Furnace Wks., Portland, Ore.
●National Fan & Blower Corp., Chicago, Ill.
New York Blower Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Northern Blower Co., Cleveland, O.
Pangborn Corp., Hagerstown, Md.
Peerless Electric Co., Warren, O.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Smith Heater Co., Peter, Detroit, Mich.
Schwitzer-Cummings Co., Indianapolis, Ind.
Spencer Turbine Co., Hartford, Conn.
●Sturtevant Co., B. F., Boston, Mass.
Supreme Heater & Ventilating Corp., St. Louis, Mo.
●Torrington Mfg. Co., Torrington, Conn.
●Trane Co., La Crosse, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Utility Fan & Mfg. Co., Los Angeles, Cal.
Viking Air Conditioning Corp., Cleveland, O.
Western Blower Co., Seattle, Wash.
●Wing Mfg. Co., L. J., New York, N. Y.

FANS, PROPELLER

Aerovent Fan Co., Piqua, O.
Air Controls, Inc., Cleveland, O.
Aircraft Mfg. Co., Dayton, O.
Air Devices Corp., Chicago, Ill.
Airmaster Corp., Chicago, Ill.
American Blower Corp., Detroit, Mich.
American Coolair Corp., Jacksonville, Fla.
Ames Co., W. R., San Francisco, Cal.
Arex Co., Chicago, Ill.
●Autovent Fan & Blower Co., Chicago, Ill.
Bayley Blower Co., Milwaukee, Wis.
Belco Exhaust Fan Mfg. Co., St. Louis, Mo.
Bendix Products Corp., South Bend, Ind.
●Buffalo Forge Co., Buffalo, N. Y.
Campbell Heating Co., E. K., Kansas City, Mo.
Champion Blower & Forge Co., Lancaster, Pa.
●Clarage Fan Co., Kalamazoo, Mich.
Coppus Engineering Corp., Worcester, Mass.
Dallas Engineering Corp., Dallas, Tex.
Davenport Mfg. Co., Meadville, Pa.
De Bothezat Div., American Machine & Metals Mfg. Corp., New York, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dixie Mfg. Co., Inc., Baltimore, Md.
Economy Electric Mfg. Co., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
Evry-Use Products, Inc., New York, N. Y.
Fresh'nd-Aire Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.
Hartzell Propeller Fan Co., Piqua, O.
●Henry Furnace & Foundry Co., Cleveland, O.
Ilg Electric Ventilating Co., Chicago, Ill.
International Engineering, Inc., Dayton, O.
Johnson Fan & Blower Corp., Chicago, Ill.
Johnston Co., William W., Dayton, O.
Jordan & Co., Paul R., Indianapolis, Ind.
King Ventilating Co., Owatonna, Minn.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Mechanical Air, Little Rock, Ark.
Meier Electric & Machine Co., Indianapolis, Ind.
Myers Electric Co., Pittsburgh, Pa.
●National Fan & Blower Corp., Chicago, Ill.
New York Blower Co., Chicago, Ill.
Peerless Electric Co., Warren, O. (Disc).
Perkins & Son, Inc., B. F., Holyoke, Mass.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Propellair, Inc., Springfield, O.
Reed Unit-Fans, Inc., New Orleans, La.
Robbins & Myers, Inc., Springfield, O.
Russell Electric Co., Chicago, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
●Sturtevant Co., B. F., Boston, Mass.
●Torrington Mfg. Co., Torrington, Conn.
Utility Fan & Mfg. Co., Los Angeles, Cal.
Vallen, Inc., Akron, O.
Viking Air Conditioning Corp., Cleveland, O.
Western Blower Co., Seattle, Wash.
●Wing Mfg. Co., L. J., New York, N. Y.

FEEDERS, WATER, HEATING BOILER

Beaton & Cadwell Mfg. Co., New Britain, Conn.
Cissell Mfg. Co., W. M., Louisville, Ky.
Davis Regulator Co., Chicago, Ill.
Eclipse Fuel Engineering Co., Rockford, Ill.
Foster Wheeler Corp., New York, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Lawler Automatic Controls, Inc., Mount Vernon, N. Y.
Maid-O-Mist, Inc., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
McDonnell & Miller, Chicago, Ill.
●Mears-Kane-Ofeldt, Inc., Philadelphia, Pa. (High pressure boiler).
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watts Regulator Co., Lawrence, Mass.
●Webster & Co., Warren, Camden, N. J.
●Worthington Pump & Machinery Corp., Harrison, N. J.

FIBRE PACKING

See Packing, Fibre

FILTERS, AIR, AUTOMATIC

●American Air Filter Co., Inc., Louisville, Ky.
Bubar, Hudson H., New York, N. Y.
Burt Air Filter Corp., New York, N. Y.
Coppus Engineering Corp., Worcester, Mass.
Dracco Corp., Cleveland, O.
Hugo Mfg. Co., West Duluth, Minn.
●Independent Air Filter Co., Chicago, Ill.
Northern Blower Co., Cleveland, O.
●Staynew Filter Corp., Rochester, N. Y.

FILTERS, AIR, UNIT, DRY

●American Air Filter Co., Inc., Louisville, Ky.
● Annis, Emmett F., Glendale, Cal.
Anson Industrial Co., New York, N. Y.
Bubar, Hudson H., New York, N. Y.
Burt Air Filter Corp., New York, N. Y.
Consolidated Air Conditioning Corp., New York, N. Y. (Odor adsorbers)
Coppus Engineering Corp., Worcester, Mass.
Davies Air Filter Co., New York, N. Y.
Dracco Corp., Cleveland, O.
Greene Gas Cleaner Co., Cleveland, O.
Hugo Mfg. Co., West Duluth, Minn.
●Independent Air Filter Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Kleenaire Corp., Stevens Point, Wis.
Somers, Inc., H. J., Detroit, Mich.
●Staynew Filter Corp., Rochester, N. Y.
Universal Air Filter Corp., Duluth, Minn.

FILTERS, AIR, UNIT, VISCOUS

●Air-Maze Corp., Cleveland, O.
●American Air Filter Co., Inc., Louisville, Ky.
●American Radiator Co., New York, N. Y.
Bache & Co., Semon, New York, N. Y.
Bubar, Hudson H., New York, N. Y.
●Independent Air Filter Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Kleenaire Corp., Stevens Point, Wis.
●Owens-Illinois Glass Co., Newark, O.
Plymouth Cordage Co., N. Plymouth, Mass.
Ripley Co., W. R., Tacoma, Wash.
Russell Electric Co., Chicago, Ill.
Wilson & Co., Chicago, Ill.

FILTERS, PIPE LINE

Adams Co., R. P., Buffalo, N. Y.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Cuno Engineering Corp., Meriden, Conn.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.

Jenkins Bros., New York, N. Y.
Johnson Corp., Three Rivers, Mich.
Ludcke Corp., Watertown, Mass.
Norwood Engineering Co., Florence, Mass.
Permutit Co., New York, N. Y.

FINNED TUBING

See Tubing, Finned

FIRE PUMPS

See Pumps, Fire

FITTINGS, COPPER TUBE, COMPRESSION

•American Brass Co., Waterbury, Conn.
American Injector Co., Detroit, Mich.
Chase Brass & Copper Co., Waterbury, Conn.
Commonwealth Brass Corp., Detroit, Mich.
•Crane Co., Chicago, Ill.
Dole Valve Co., Chicago, Ill.
Dresser Mfg. Co., S. R., Bradford, Pa.
Hays Mfg. Co., Erie, Pa.
Imperial Brass Mfg. Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Malleable Iron Fittings Co., Branford, Conn.
Northern Indiana Brass Co., Elkhart, Ind.
Phoenix Brass Fittings, Corp., Irvington, N. J.
•Revere Copper & Brass, Inc., New York, N. Y.
•Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
Union Metal Wks., Inc., Chelsea, Mass.
Weatherhead Co., Cleveland, O.

FITTINGS, COPPER TUBE, SOLDER

•American Brass Co., Waterbury, Conn.
American Injector Co., Detroit, Mich.
•American Radiator Co., New York, N. Y.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Commonwealth Brass Corp., Detroit, Mich.
•Crane Co., Chicago, Ill.
Imperial Brass Mfg. Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Northern Indiana Brass Co., Elkhart, Ind.
•Revere Copper & Brass, Inc., New York, N. Y.
•Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
Union Metal Wks., Inc., Chelsea, Mass.
Weatherhead Co., Cleveland, O.
Wolverine Tube Co., Detroit, Mich.

FITTINGS, LINED

Goodrich Co., B. F., Akron, O. (Rubber)
Lead Lined Iron Pipe Co., Wakefield, Mass. (Lead and tin)
National Lead Co., New York, N. Y. (Lead)
Northern Indiana Brass Co., Elkhart, Ind. (Tinned)
Resisto Pipe & Valve Co., East Cambridge, Mass.
United States Rubber Products, Inc., New York, N. Y. (Rubber)

FITTINGS, PIPE, BRASS, SOLDER

Commonwealth Brass Corp., Detroit, Mich.
•Crane Co., Chicago, Ill.
Grabler Mfg. Co., Cleveland, O.
Imperial Brass Mfg. Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Northern Indiana Brass Co., Elkhart, Ind.
•Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
Union Metal Wks., Inc., Chelsea, Mass.
•Walworth Co., New York, N. Y. (Brazed)
Wolverine Tube Co., Detroit, Mich.

FITTINGS, PIPE, BRASS, THREADED

Acheson Mfg. Co., Rankin, Pa.
American Manganese Bronze Co., Philadelphia, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
Commonwealth Brass Corp., Detroit, Mich.
•Crane Co., Chicago, Ill.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
General Fittings Co., Providence, R. I.
Grabler Mfg. Co., Cleveland, O.
•Grinnell Co., Inc., Providence, R. I.
Imperial Brass Mfg. Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
New York Brass Fdry., New York, N. Y.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
Phoenix Brass Fittings Corp., Irvington, N. J.
Pittsburgh Valve & Fittings Corp., Barberton, O.
•Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
Union Metal Wks., Inc., Chelsea, Mass.
•Walworth Co., New York, N. Y.
Weatherhead Co., Cleveland, O.

FITTINGS, PIPE, BRASS, WELDING

•Bonney Forge & Tool Wks., Allentown, Pa.
•Tube-Turns, Inc., Louisville, Ky.

FITTINGS, PIPE, CAST IRON

American Cast Iron Pipe Co., Birmingham, Ala.
Clow, Jas. B. & Sons, Chicago, Ill.
•Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill. (Steam-jacketed)
Devlin Mfg. Co., Thos., Burlington, N. J.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
Grabler Mfg. Co., Cleveland, O.
•Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
•Kuhns Bros. Co., Dayton, O.
Lumsden Van Stone Co., South Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Semler Co., Jeannette, Pa.
Stockham Pipe & Fittings Co., Birmingham, Ala.
•Walworth Co., New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.

FITTINGS, PIPE, LEAD

Andrews Lead Co., Inc., Long Island City, N. Y.
Eagle-Picher Lead Co., Cincinnati, O.
Flemm Lead Co., Inc., Iong Island City, N. Y.
Lissberger & Son, Inc., Marks, Long Island City, N. Y.
National Lead Co., New York, N. Y.

FITTINGS, PIPE, MALLEABLE

•Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Thos., Burlington, N. J.
Dresser Mfg. Co., S. R., Bradford, Pa.
Duriron Co., Inc., Dayton, O. (Acid-resisting)
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
General Fittings Co., Providence, R. I.
Grabler Mfg. Co., Cleveland, O.
•Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Malleable Iron Fittings Co., Branford, Conn.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Rhode Island Fittings Co., Hillsgrove, R. I.
Stockham Pipe & Fittings Co., Birmingham, Ala.
•Walworth Co., New York, N. Y.
Ward Foundry, Inc., J. P., Blossburg, Pa.

FITTINGS, PIPE, STEEL, FLANGED

Central Forging Co., Catawissa, Pa.
•Crane Co., Chicago, Ill.
Devlin Mfg. Co., Thos., Burlington, N. J.
Lumsden Van Stone Co., South Boston, Mass.
•Reading-Pratt & Cady Co., Bridgeport, Conn.
Semet-Solvay Engrg. Corp., New York, N. Y.
Taylor Forge & Pipe Wks., Chicago, Ill.
Vogt Machine Co., Henry, Louisville, Ky.
•Walworth Co., New York, N. Y.
•Watson-Stillman Co., Roselle, N. J.

FITTINGS, PIPE, STEEL, THREADED

•Bonney Forge & Tool Wks., Allentown, Pa.
•Crane Co., Chicago, Ill.
Devlin Mfg. Co., Thos., Burlington, N. J.
Laclede Steel Co., St. Louis, Mo.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
•Reading-Pratt & Cady Co., Bridgeport, Conn.
Vogt Machine Co., Henry, Louisville, Ky.
•Walworth Co., New York, N. Y.
•Watson-Stillman Co., Roselle, N. J.

FITTINGS, PIPE, STEEL, WELDING

•Bonney Forge & Tool Wks., Allentown, Pa.
•Crane Co., Chicago, Ill.
•Grinnell Co., Inc., Providence, R. I.
Larkin Packer Co., St. Louis, Mo.
•Midwest Piping & Supply Co., St. Louis, Mo.
Oil Well Supply Co., Oil City, Pa.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
Semet-Solvay Engineering Corp., New York, N. Y.
Taylor Forge & Pipe Wks, Chicago, Ill.
•Tube-Turns, Inc., Louisville, Ky.
•Walworth Co., New York, N. Y.
Wedge Protectors, Inc., Cleveland, O. (Chill rings)

FITTINGS, PIPE, WROUGHT IRON, WELDING

•Bonney Forge & Tool Wks., Allentown, Pa.
•Grinnell Co., Inc., Providence, R. I.
•Midwest Piping & Supply Co., Inc., St. Louis, Mo.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
Taylor Forge & Pipe Wks, Chicago, Ill.
•Walworth Co., New York, N. Y.

FITTINGS, REFRIGERATION

•Baker Ice Machine Co., Inc., Omaha, Nebr.
•Carbondale Machine Corp., Harrison, N. J.
Chase Brass & Copper Co., Waterbury, Conn.
Commonwealth Brass Corp., Detroit, Mich.
•Crane Co., Chicago, Ill.
•Electrimatic Corp., Chicago, Ill.
•Frick Co., Waynesboro, Pa.
Henry Valve Co., Chicago, Ill.
Imperial Brass Mfg. Co., Chicago, Ill.
Kerotest Mfg. Co., Pittsburgh, Pa.
Perfection Refrigeration Parts Co., Harvey, Ill.
Triumph Ice Machine Co., Cincinnati, O.

●Vilter Mfg. Co., Henry, Louisville, Ky.
Vogt Machine Co., Henry, Louisville, Ky.
Weatherhead Co., Cleveland, O.
Wittenmeier Machinery Co., Chicago, Ill.
●York Ice Machinery Corp., York, Pa.
X L Refrigerating Co., Inc., Chicago, Ill.

FLANGE BOLTS

See Bolts and Studs, Flange

FLANGES, PIPE

American Cast Iron Pipe Co., Birmingham, Ala.
●American District Steam Co., North Tonawanda, N. Y.
●Crane Co., Chicago, Ill.
Clow, Jas. B. & Sons, Chicago, Ill.
●Dart Mfg. Co., E. M., Providence, R. I.
Devlin Mfg. Co., Thos., Burlington, N. J.
●Grinnell Co., Inc., Providence, R. I.
Harrisburg Steel Corp., Harrisburg, Pa.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y. (Brass only)
Kennedy Valve Mfg. Co., Elmira, N. Y.
●Kuhns Bros. Co., Dayton, O.
Limbert & Co., Geo. B., Chicago, Ill.
Lumsden Van Stone Co., South Boston, Mass.
●Midwest Piping & Supply Co., St. Louis, Mo.
National Valve & Mfg. Co., Pittsburgh, Pa.
Pennsylvania Forge Co., Philadelphia, Pa.
●Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Pittsburgh Valve Foundry & Construction Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Semler Co., Jeannette, Pa.
Steel Improvement & Forge Co., Cleveland, O.
Taylor Forge & Pipe Wks., Chicago, Ill.
Vogt Machine Co., Henry, Louisville, Ky.
●Walworth Co., New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.

FLEXIBLE COUPLINGS

See Couplings, Flexible

FLOATS, STEAM TRAP, ETC.

●Clark Controller Co., Cleveland, O.
Fisher Governor Co., Marshalltown, Ia.
Harris & Co., Arthur, Chicago, Ill.
Hercules Float Wks., Springfield, Mass.
McAlear Mfg. Co., Chicago, Ill.
Naugatuck Mfg. Co., Naugatuck, Conn.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Reichert Float & Mfg. Co., Toledo, O.
Reliance Gauge Column Co., Cleveland, O.
Sterling Engineering Co., Milwaukee, Wis.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., 440 N. Marshall, Philadelphia, Pa.
Williams Gauge Co., Pittsburgh, Pa.
Wright-Austin Co., Detroit, Mich.

FLOAT SWITCHES

See Switches, Float

FLOAT VALVES

See Valves, Float

FLOOR AND CEILING PLATES

See Plates, Floor and Ceiling

FLOW METERS

See Meters, Flow

FORGED STEEL VALVES

See Valves, Forged Steel

FURNACES, WARM AIR, FOR INDUSTRIAL AND LARGE BUILDING HEATING

Acme Heating & Ventilating Co., Inc., Chicago, Ill.
●Airtherm Mfg. Co., St. Louis, Mo.
American Foundry & Furnace Co., Bloomington, Ill.
Campbell Heating Co., Des Moines, Ia.
Campbell Heating Co., E. K., Kansas City, Mo.
Forest City Foundries Co., Cleveland, O.
Hart & Crouse Co., Inc., Utica, N. Y.
●Henry Furnace & Foundry Co., Cleveland, O.
International Heater Co., Utica, N. Y.
Lee Heating Systems, Youngstown, O.
Magirl Foundry & Furnace Wks., P. H. Bloomington, Ill.
Moncrief Furnace Co., Atlanta, Ga.
Montag Stove & Furnace Wks., Portland, Ore.
Mueller Furnace Co., L. J., Milwaukee, Wis.
New York Blower Co., Chicago, Ill.
Nugent Sons, Inc., Thos., New York, N. Y.
Payne Furnace & Supply Co., Beverly Hills, Cal.
Reif-Rexoil, Inc., Buffalo, N. Y.
Ross Engineering Corp., J. O., New York, N. Y.
Smith, Inc., James Campbell, Cleveland, O.
Spear Stove & Heating Co., James, Philadelphia, Pa.
Surface Combustion Corp., Toledo, O.
Thatcher Co., Newark, N. J.
Western Furnaces, Inc., Tacoma, Wash.
XXth Century Heating & Ventilating Co., Akron, O.

GAGES, INDICATING, DRAFT

A. C. E., Inc., Chicago, Ill.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
Ellison Draft Gage Co., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
Hays Corp., Michigan City, Ind.
Moeller Instrument Co., Richmond Hill, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Scientific Instrument Co., Detroit, Mich.
Spence Engrg. Co., Inc., Walden, N. Y.
Uehling Instrument Co., Paterson, N. J.

GAGES, INDICATING, PRESSURE

A. C. E., Inc., Chicago, Ill.
Anderson Products, Inc., Cambridge, Mass.
Ashton Valve Co., Cambridge, Mass.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Bailey Meter Co., Cleveland, O.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
Belfield Co., H., Philadelphia, Pa.
Bordo Co., Inc., L. J., Glenside, Pa.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
Detroit Brass & Malleable Wks., Detroit, Mich.
●Dunham Co., C. A., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
Hays Corp., Michigan City, Ind.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Lonergan Co., J. E., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
Moeller Instrument Co., Richmond Hill, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Rochester Mfg. Co., Inc., Rochester, N. Y.
Russell & Co., W. A., New York, N. Y.
Star Brass Mfg. Co., Boston, Mass.
Sterling Engineering Co., Milwaukee, Wis.
●Taylor Instrument Companies, Rochester, N. Y.
●Trane Co., La Crosse, Wis.
Uehling Instrument Co., Paterson, N. J.
United States Gauge Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

GAGES, INDICATING, VACUUM

Anderson Products, Inc., Cambridge, Mass.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Ashton Valve Co., Cambridge, Mass.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
Bailey Meter Co., Cleveland, O.
Belfield Co., H., Philadelphia, Pa.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
Dole Valve Co., Chicago, Ill.
●Dunham Co., C. A., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
General Electric Co., Schenectady, N. Y.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Lonergan Co., J. E., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
Moeller Instrument Co., Richmond Hill, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Russell & Co., W. A., New York, N. Y.
Star Brass Mfg. Co., Boston, Mass.
Sterling Engineering Co., Milwaukee, Wis.
●Taylor Instrument Companies, Rochester, N. Y.
Uehling Instrument Co., Paterson, N. J.
United States Gauge Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

GAGES, LIQUID LEVEL

●Bristol Co., Waterbury, Conn.
Boston Auto Gage Co., Pittsfield, Mass.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Caldwell Co., W. E. Louisville, Ky.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Foxboro Co., Foxboro, Mass.
King-Seeley Corp., Ann Arbor, Mich.

Klingerit, Inc., New York, N. Y.
Liquidometer Corp., Long Island City, N. Y.
Lonergan Co., J. E., Philadelphia, Pa.
Petrometer Corp., Long Island City, N. Y.
Reliance Gauge Column Co., Cleveland, O.
Republic Flow Meters Co., Chicago, Ill.
Rochester Mfg. Co., Rochester, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Scientific Instrument Co., Detroit, Mich.
●Taylor Instrument Companies, Rochester, N. Y.
Uehling Instrument Co., Paterson, N. J.
United States Gauge Co., New York, N. Y.
Viking Pump Co., Cedar Falls, Ia.
Wright-Austin Co., Detroit, Mich.
●Yarnall-Waring Co., Philadelphia, Pa.

GALVANIZED SHEETS

See Sheets, Iron and Steel, Galvanized

GAS BURNERS

See Burners, Gas

GAS ENGINES

See Engines, Gas

GAS PRESSURE REGULATORS

See Regulators, Pressure, Gas

GASKETS

Akron Metallic Gasket Co., Akron, O. (Metal & metal asbestos)
Anchor Packing Co., Philadelphia, Pa. (Asbestos)
●Armstrong Cork Products Co., Lancaster, Pa. (Cork & cork composition)
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Chicago-Wilcox Mfg. Co., Chicago, Ill.
Continental Diamond Fibre Co., Newark, Del.
Continental Rubber Wks., Erie, Pa.
Crandall Packing Co., Palmyra, N. Y. (Asbesto, rubber)
Crane Packing Co., Chicago, Ill.
Darcoid Co., Inc., New York, N. Y. (Asbestos)
Durabla Mfg. Co., New York, N. Y. (Asbestos fibre)
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Endura Mfg. Corp., Quakertown, Pa. (Paper, fibre)
●Frick Co., Waynesboro, Pa.
Garlock Packing Co., Palmyra, N. Y. (Rubber, asbestos, fibre, semi-metallic)
Gatke Corp., Chicago, Ill.
Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.
Goodrich Co., B. F., Akron, O.
Graton & Knight Co., Worcester, Mass. (Leather)
Flexitallic Gasket Co., Camden, N. J. (Metal, asbestos)
Jenkins Bros., New York, N. Y. (Ring asbestos or rubber sheet)
Johns-Manville, New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa. (Asbestos)
Klingerit, Inc., New York, N. Y.
Metallo Gasket Co., New Brunswick, N. J. (Metal, metal asbestos)
National Boiler Improvement Co., Washington, D. C.
Ruberoid Co., New York, N. Y. (Asbestos)
Smooth-On Mfg. Co., Jersey City, N. J.
Stokes Rubber Co., Jos., Trenton, N. J. (Hard rubber)
United States Rubber Products, Inc., New York, N. Y. (Rubber, asbestos)
Western Felt Wks., Chicago, Ill. (Felt)

GATE VALVES

See Valves, Gate

GLASS PIPE

See Pipe, Glass

GLOBE VALVES

See Valves, Globe

GOVERNORS, PUMP

Bailey Meter Co., Cleveland, O.
Boylston Steam Specialty Co., Chicago, Ill.
Burrows Mfg. Co., F. A., York, Pa.
Cash Co., A. W., Decatur, Ill.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
●Dunham Co., C. A., Chicago, Ill.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Gardner-Denver Co., Quincy, Ill.
Illinois Engineering Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Keckley Co., O. C., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Leslie Co., Lyndhurst, N. J.
Locke Regulator Co., Salem, Mass.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Schwitzer-Cummins Co., Indianapolis, Ind.
Spence Engineering Co., Inc., Walden, N. Y.
Squires Co., C. E., Cleveland, O.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.
Watts Regulator Co., Lawrence, Mass.
●Webster & Co., Warren, Camden, N. J.
Williams Gauge Co., Pittsburgh, Pa.
Wright-Austin Co., Detroit, Mich.

GRILLES

Aircraft Mfg. Co., Dayton, O.
American Blower Corp., Detroit, Mich.
American Foundry & Furnace Co., Bloomington, Ill.
American Warming & Ventilating Co., Toledo, O.
●Anemostat Corp. of America, New York, N. Y. (High velocity air diffusers)
●Auer Register Co., Cleveland, O.
●Barber-Colman Co., Rockford, Ill.
Best Register Co., Milwaukee, Wis.
Campbell Heating Co., Des Moines, Ia.
Campbell Heating Co., E. K., Kansas City, Mo.
Cross Engineering Co., Carbondale, Pa.
Diamond Mfg. Co., Wyoming, Pa.
Erdle Perforating Co., Rochester, N. Y.
Globe Machine & Stamping Co., Cleveland, O.
Harrington & King Perforating Co., Chicago, Ill.
Hart & Cooley Mfg. Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.
●Independent Register Co., Cleveland, O.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Knowles Mushroom Ventilator Co., New York, N. Y.
Metalace Corp., So. Boston, Mass.
Mueller Furnace Co., L. J., Milwaukee, Wis.
Register & Grille Mfg. Co., Brooklyn, N. Y.
Rock Island Register Co., Rock Island, Ill.
●Trane Co., La Crosse, Wis.
●Tuttle & Bailey, Inc., New Britain, Conn.
U. S. Air Conditioning Corp., Minneapolis, Minn.
United States Register Co., Battle Creek, Mich.
●Waterloo Register Co., Waterloo, Ia.
Wickwire Spencer Steel Co., New York, N. Y.

HAND SHEARS

See Shears, Hand

HANGERS OR BRACKETS, RADIATOR

American Foundry & Furnace Co., Bloomington, Ill.
●American Radiator Co., New York, N. Y.
Carpenter & Paterson, Inc., East Boston, Mass.
Carty & Moore Engineering Co., Detroit, Mich.
Chicago Nipple Mfg. Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Crawford Co., Chicago, Ill.
Grabler Mfg. Co., Cleveland, O.
●Grinnell Co., Inc., Providence, R. I.
Hartmann Co., Chas., Brooklyn, N. Y.
Inland Mfg. Co., Chicago, Ill. (Unit heater hangers)
Jennison Co., Fitchburg, Mass. (Adjustable radiator foot rest)
Logansport Radiator Equipment Co., Logansport, Ind.
McAlear Mfg. Co., Chicago, Ill.
National Radiator Corp., Johnstown, Pa.
Paine Co., Chicago, Ill.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Richmond Radiator Co., Inc., Uniontown, Pa.
Sterling Engineering Co., Milwaukee, Wis.
United States Radiator Corp., Detroit, Mich.
Western Hanger Co., San Francisco, Cal.

HANGERS AND SUPPORTS, PIPE

Beaton & Cadwell Mfg. Co., New Britain, Conn.
Carpenter & Paterson, Inc., East Boston, Mass.
Chicago Nipple Mfg. Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Crawford Co., Chicago, Ill.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
Farley Sleeve & Hanger Co., Cleveland, O.
Globe Machine & Stamping Co., Cleveland, O.
Grabler Mfg. Co., Cleveland. O.
●Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Lumsden Van Stone Co., South Boston, Mass.
●Midwest Piping & Supply Co., Inc., St. Louis, Mo.
Paine Co., Chicago, Ill.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Reznor Mfg. Co., Mercer, Pa.
●Ric-wiL Co., Cleveland, O. (Underground)
Rockwood Sprinkler Co. of Mass., Worcester, Mass.
Roessing Mfg. Co., Pittsburgh, Pa.
Semler Co., Jeannette, Pa.
●Walworth Co., New York, N. Y.
Western Wire Products Co., St. Louis, Mo.

HARD RUBBER PIPE

See Pipe, Hard Rubber

HEADERS, WELDED

●Crane Co., Chicago, Ill.
Columbian Steel Tank Co., Kansas City, Mo.
Floersheim & Co., B., Pittsburgh. Pa.
●Grinnell Co., Inc., Providence, R. I.
International Engineering Wks., Inc., Framingham, Mass.
Kellogg Co., M. W., New York, N. Y.
Limbert & Co., Geo. B., Chicago, Ill.

Lumsden Van Stone Co., South Boston, Mass.
●Midwest Piping & Supply Co., Inc., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
National Valve & Mfg. Co., Pittsburgh, Pa.
Ohio Pipe Bending & Mach. Co., Cleveland, O.
Parks-Cramer Co., Fitchburg, Mass.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Pittsburgh Pipe Coil & Bending Co., Etna, Pa.
●Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.
Roessing Mfg. Co., Pittsburgh, Pa.
Sales & Co., Murray W., Detroit, Mich.
Semet-Solvay Engineering Corp., New York N. Y.
Shaw Co., Benjamin F., Wilmington, Del.
●Walworth Co., New York, N. Y.

HEADS, SPRINKLER

Cleghorn Co., Boston, Mass.
●Grinnell Co., Inc., Providence, R. I.
Hodgman Mfg. Co., Taunton, Mass.
Raisler Sprinkler Co., New York, N. Y.
Rockwood Spjrinkler Co., Worcester, Mass.

HEAT EXCHANGERS

See Exchangers, Heat

HEATERS, AIR, DIRECT FIRED

●Airtherm Mfg. Co., St. Louis, Mo.
Bryant Heater Co., Cleveland, O.
Dravo-Doyle Co., Pittsburgh, Pa.
Lee Heating Systems, Youngstown, O.
Magirl Foundry & Furnace Wks., P. H., Bloomington, Ill.
New York Blower Co., Chicago, Ill.
Ross Engineering Corp., J. O., New York, N. Y.
Williams, Inc., F. C. Dearborn, Mich.

HEATERS, DUCT, ELECTRIC

General Electric Co., Schenectady, N. Y.
Hynes Electric Heating Co., Philadelphia, Pa.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Wiegand Co., Edwin L., Pittsburgh, Pa.

HEATERS, SPACE, ELECTRIC

●Burnham Boiler Corp., Irvington, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wis.
Economy Electric Mfg. Co., Chicago, Ill.
Electric Air Heater Co., Div. American Foundry Equipment Co., Mishawaka, Ind.
Electric Research Laboratories, Warren, Pa.
General Electric Co., Schenectady, N. Y.
Hynes Electric Heating Co., Philadelphia, Pa.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Wiegand Co., Edwin L., Pittsburgh, Pa.

HEATERS, STRIP AND IMMERSION, ELECTRIC

Cutler-Hammer, Inc., Milwaukee, Wis.
Electric Hot Heater Co., Tacoma, Wash.
General Electric Co., Schenectady, N. Y.
Hynes Electric Heating Co., Philadelphia, Pa.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Wiegand Co., Edwin L., Pittsburgh, Pa.

HEATERS, UNIT, ELECTRIC

Air Devices Corp., Chicago, Ill.
●Autovent Fan & Blower Co., Chicago, Ill.
Economy Electric Mfg. Co., Chicago, Ill.
Electric Air Heater Co., Div. American Foundry Equipment Co., Mishawaka, Ind.
Electric Hot Heater Co., Tacoma, Wash.
●Grinnell Co., Inc., Providence, R. I.
Hexcel Radiator Co., Racine, Wis.
Hynes Electric Heating Co., Philadelphia, Pa.
Ilg Electric Ventilating Co., Chicago, Ill.
Murray Iron Wks. Co., Burlington, Ia.
●National Fan & Blower Corp., Chicago, Ill.
●Sturtevant Co., B. F., Boston, Mass.
Warren Electric Appliance Co., Warren, Pa.
●Wiegand Co., Edwin L., Pittsburgh, Pa.

HEATERS, UNIT, GAS FIRED

Bryant Heater Co., Cleveland, O.
●Buffalo Forge Co., Buffalo, N. Y.
Campbell Heating Co., E. K., Kansas City, Mo.
Continental Stove Corp., Ironton, O.
Economy Electric Mfg. Co., Chicago, Ill.
General Gas Light Co., Kalamazoo, Mich.
Lee Heating Systems, Youngstown, O.
Mueller Furnace Co., L. J., Milwaukee, Wis.
●National Fan & Blower Corp., Chicago, Ill.
Payne Furnace & Supply Co., Beverly Hills, Cal.
Reznor Mfg. Co., Mercer, Pa.
Ross Engineering Corp., J. O., New York, N. Y.
Schoedinger, F. O., Columbus, O.
Surface Combustion Corp., Toledo, O.

HEATERS, UNIT, STEAM AND HOT WATER

Air Devices Corp., Chicago, Ill.
●Airtherm Mfg. Co., St. Louis, Mo.
American Blower Corp., Detroit, Mich.
Arex Co., Chicago, Ill.
●Autovent Fan & Blower Co., Chicago, Ill.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
Blower Application Co., Milwaukee, Wis.
●Buffalo Forge Co., Buffalo, N. Y.
●Burnham Boiler Corp., Irvington, N. Y.
Campbell Heating Co., E. K., Kansas City, Mo.
●Carrier Corp., Newark, N. J.
●Clarage Fan Co., Kalamazoo, Mich.
●Dunham Co., C. A., Chicago, Ill.
Economy Electric Mfg. Co., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
●Fedders Mfg. Co., Buffalo, N. Y.
●Grinnell Co., Inc., Providence, R. I.
Hartzell Propeller Fan Co., Piqua, O.
Ilg Electric Ventilating Co., Chicago, Ill.
Johnson Fan & Blower Corp., Chicago, Ill.
King Ventilating Co., Owatonna, Minn.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
●National Fan & Blower Corp., Chicago, Ill.
National Radiator Corp., Johnstown, Pa.
Nelson Corp., Herman, Moline, Ill.
●Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.
New York Blower Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Perfex Radiator Co., Milwaukee, Wis.
Rome-Turney Radiator Co., Rome, N. Y.
Russell Electric Co., Chicago, Ill.
St. Louis Blow Pipe & Heater Co., St. Louis, Mo.
●Sturtevant Co., B. F., Boston, Mass.
●Trane Co., La Crosse, Wis.
Thermal Units Mfg. Co., Chicago, Ill.
Trenton Auto Radiator Wks., Trenton, N. J.
●Unit Heater & Cooler Co., Wausau, Wis.
United States Radiator Corp., Detroit, Mich.
●Wing Mfg. Co., L. J., New York, N. Y.
●Young Radiator Co., Racine, Wis.

HEATERS, WATER, CAST IRON, COAL FIRED

●American Radiator Co., New York, N. Y.
●Burnham Boiler Corp., Irvington, N. Y.
Central Radiator Co., New York, N. Y.
Cleghorn Co., Boston, Mass.
●Crane Co., Chicago, Ill.
Glore Sales Corp., Evins F., New York, N. Y.
Hart & Crouse Co., Inc., Utica, N. Y.
International Heater Co., Utica, N. Y.
Molby Boiler Co., New York, N. Y.
Mueller Furnace Co., L. J., Milwaukee, Wis.
National Pipe Bending Co., New Haven, Conn.
National Radiator Corp., Johnstown, Pa.
Peerless Heater Co., Boyertown, Pa.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Prox Co., Frank, Terre Haute, Ind.
Richardson & Boynton Co., New York, N. Y.
Smith Co., H. B., Westfield, Mass.
Spencer Heater Co., Williamsport, Pa.
Thatcher Co., Newark, N. J.
Weil-McLain Co., Chicago, Ill.

HEATERS, WATER, GAS OR OIL FIRED

Bryant Heater Co., Cleveland, O.
●Crane Co., Chicago, Ill.
Dahlquist Mfg. Co., Inc., Boston, Mass.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Electrol, Inc., Clifton, N. J.
Gilbert & Barker Mfg. Co., Springfield, Mass.
International Engineering Wks., Inc., Framingham, Mass.
Johnson Co., S. T., Oakland, Cal.
Kleen-Heet, Inc., Chicago, Ill.
●Kewanee Boiler Corp., Kewanee, Ill.
Lookout Boiler & Mfg. Co., Chattanooga, Tenn.
●Mears-Kane Ofeldt, Inc., Philadelphia, Pa.
Mueller Furnace Co., L. J., Milwaukee, Wis.
National Radiator Corp., Johnstown, Pa.
Norge Heating & Conditioning Div., Borg-Warner Corp., Dertoit, Mich.
Nu-Way Corp., Rock Island, Ill.
Pittsburgh Water Heater Co., Pittsburgh, Pa.
Reif-Rexoil, Inc., Buffalo, N. Y.
Richardson & Boynton Co., New York, N. Y.
Rotary Mfg. Co., Los Angeles, Cal.
Ruud Mfg. Co., Los Angeles, Cal.
Surface Combustion Corp., Toledo, O.
United American Bosch Corp., Springfield, Mass.
United States Radiator Corp., Detroit, Mich.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
Wood Industries, Inc., Gar., Detroit, Mich.

HEATERS, WATER, INDIRECT

Adams Engineering Co., Chicago, Ill.
Akwa Heaters, Inc., New York, N. Y.
Bell & Gossett Co., Chicago, Ill.
Bryan Steam Corp., Peru, Ind.
Chase Brass & Copper Co., Waterbury, Conn.
Croll-Reynolds Engineering Co., Inc., New York, N. Y.

Davis Engineering Corp., Elizabeth, N. J.
Excelso Products Corp., Buffalo, N. Y.
Ferguson & Lange Foundry Co., Chicago, Ill.
General Fittings Co., Providence, R. I.
Little Mfg. Co., M. S., Hartford, Conn.
Marion Machine Foundry & Supply Co., Marion, Ind.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Riverside Boiler Wks., Inc., Cambridge, Mass.
Sterling Engineering Co., Milwaukee, Wis.
Stevens-Root Co., Chicago, Ill.
Taco Heaters, Inc., Brooklyn, N. Y.
Watts Regulator Co., Lawrence, Mass.

HEATERS, WATER, STEAM, INSTANTANEOUS

Davis Engineering Corp., Elizabeth, N. J.
Eclipse Fuel Engineering Co., Rockford, Ill.
General Fittings Co., Providence, R. I.
Graham Mfg. Co., Buffalo, N. Y.
Griscom-Russell Co., New York, N. Y.
Hasco Valve & Machine Co., Milwaukee, Wis.
Howard Iron Wks. & Alberger Heater Co., Buffalo, N. Y.
Johnson Corp., Three Rivers, Mich.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Marion Machine Foundry & Supply Co., Marion, Ind.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Sims Co., Erie, Pa.
Sterling Engineering Co., Milwaukee, Wis.
Taco Heaters, Inc., Brooklyn, N. Y.

HEATERS, WATER, STEEL, COAL FIRED

Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
•Fitzgibbons Boiler Co., New York, N. Y.
International Engineering Wks., Inc., Framingham, Mass.
Johnston Bro., Inc., Ferrysburg, Mich.
•Kewanee Boiler Corp., Kewanee, Ill.
Lookout Boiler & Mfg. Co., Chattanooga, Tenn.
National Radiator Corp., Johnstown, Pa.
Spencer Heater Co., Williamsport, Pa.

HEATERS, WATER, STORAGE

•American District Steam Co., North Tonawanda, N. Y.
Bigelow Co., New Haven, Conn.
Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
Bryant Heater Co., Cleveland, O.
•Burnham Boiler Corp., Irvington, N. Y.
Chase Brass & Copper Co., Waterbury, Conn.
Cleghorn Co., Boston, Mass.
•Crane Co., Chicago, Ill.
Dahlquist Mfg. Co., Inc., Boston, Mass.
Davis Engineering Corp., Elizabeth, N. J.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Frank Engineering Co., New York, N. Y.
General Fittings Co., Povidence, R. I.
Gerstein & Cooper Co., South Boston, Mass.
Griscom-Russell Co., New York, N. Y.
Hotstream Heater Co., Cleveland, O.
Howard Iron Wks. & Alberger Heater Co., Buffalo, N. Y.
Hynes Electric Heating Co., Philadelphia, Pa.
International Engineering Wks., Inc., Framingham, Mass.
Johnson Corp., Three Rivers, Mich.
•Kewanee Boiler Corp., Kewanee, Ill.
Manitowoc Boiler Wks., Manitowoc, Wis.
•Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Milwaukee Reliance Boiler Wks., Milwaukee, Wis.
Mueller Furnace Co., L. J., Milwaukee, Wis.
National Pipe Bending Co., New Haven, Conn.
National Radiator Corp., Johnstown, Pa.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Riverside Boiler Wks., Inc., Cambridge, Mass.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Rotary Mfg. Co., Los Angeles, Cal.
Sims Co., Erie, Pa.
Taco Heaters, Inc., Brooklyn, N. Y.
Vogt Machine Co., Henry, Louisville, Ky.
Warren Electric Appliance Co., Warren, Pa. (Electric)
Whitlock Coil Pipe Co., Hartford, Conn.

HEATING BOILERS

See Boilers, Heating

HEATING SURFACE

See Surface, Heating

HOT WATER PRESSURE REGULATORS

See Regulators, Pressure, Hot Water Heating Systems

HUMIDIFIERS, CENTRAL PLANT

•Armstrong Machine Wks., Three Rivers, Mich.
•Barber-Colman Co., Rockford, Ill.
•Johnson Service Co., Milwaukee, Wis.
•Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
•Powers Regulator Co., Chicago, Ill.

HUMIDIFIERS, DIRECT, SPRAY HEAD

American Moistening Co., Providence, R. I.
Ames Co., W. R., San Francisco, Cal.
Anetsberger Bros., Chicago, Ill.
Bahnson Co., Winston-Salem, N. C.
Betz Unit Air Cooler Co., Kansas City, Mo.
•Binks Mfg. Co., Chicago, Ill.
Blower Application Co., Milwaukee, Wis.
•Buffalo Forge Co., Buffalo, N. Y.
Campbell Heating Co., E. K., Kansas City, Mo.
•Carrier Corp., Newark, N. J.
Columbus Humidifier Co., Columbus, O.
International Moistening Co., Providence, R. I.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Manufacturers Machine Co., North Andover, Mass.
•Marley Co., Kansas City, Mo.
Montag Stove & Furnace Wks., Portland, Ore.
Mueller Furnace Co., L. J., Milwaukee, Wis.
New York Blower Co., Chicago, Ill.
Nugent Sons, Inc., Thos., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Rega Mfg. Co., Rochester, N. Y.
Rhode Island Humidifier & Ventilating Co., Boston, Mass.
Rochester Mfg. Co., Inc., Rochester, N. Y.
Ross Sprinkler Co., Pasadena, Cal.
Russell Electric Co., Chicago, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
Somers, Inc., H. J., Detroit, Mich.
Southworth Machine Co., Portland, Me.
Thermal Units Mfg. Co., Chicago, Ill.
Utility Fan & Mfg. Co., Los Angeles, Cal.

HUMIDIFIERS, UNIT, ROOM TYPE (Without Heating)

American Moistening Co., Providence, R. I.
Bahnson Co., Winston-Salem, N. C.
Betz Unit Air Cooler Co., Kansas City, Mo.
Bryant Heater Co., Cleveland, O.
•Clarage Fan Co., Kalamazoo, Mich.
Columbus Humidifier Co., Columbus, O.
Corozone Air Conditioning Corp., Cleveland, O.
Hugo Mfg. Co., Duluth, Minn.
International Moistening Co., Providence, R. I.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Pamco Conditionaire Co., Chicago, Ill.
Parks-Cramer Co., Fitchburg, Mass.
Sheer Co., H. M., Quincy, Ill.
Somers, Inc., H. J., Detroit, Mich.
Southworth Machine Co., Portland, Me.
Standard Engineering Wks., Pawtucket, R. I.
United American Bosch Corp., Springfield, Mass.

HUMIDISTATS

American Moistening Co., Providence, R. I.
•Automatic Products Co., Milwaukee, Wis.
Bahnson Co., Winston-Salem, N. C.
•Barber-Colman Co., Rockford, Ill.
•Bristol Co., Waterbury, Conn.
Consolidated Ashcroft Hancock Co., Bridgeport, Conn.
•Detroit Lubricator Co., Detroit, Mich.
Foxboro Co., Foxboro, Mass.
•Friez & Sons, Inc., Julien P., Baltimore, Md.
G. M. Mfg. Co., New York, N. Y.
H-B Instrument Co., Philadelphia, Pa.
•Johnson Service Co., Milwaukee, Wis.
Johnson Tool Co., Inc., East Providence, R. I.
•Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
•Powers Regulator Co., Chicago, Ill.
Ripley Co., W. R., Tacoma, Wash.
Russell Electric Co., Chicago, Ill.
Somers, Inc., H. J., Detroit, Mich.
Standard Engineering Wks., Pawtucket, R. I.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
•Taylor Instrument Companies, Rochester, N. Y.

HUMIDITY RECORDERS

See Recorders, Humidity

HYDRAULIC PUMPS

See Pumps, Hydraulic

HYGROMETERS

A. C. E., Inc., Chicago, Ill.
American Moistening Co., Providence, R. I.
Bahnson Co., Winston-Salem, N. C.
•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Bridgeport, Conn.
Dusinberre Indicator Co., Kew Gardens, N. Y.
Fee and Stemwedel, Inc., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
•Friez & Sons, Inc., Julien P., Baltimore, Md.
G. M. Mfg. Co., New York, N. Y.
H-B Instrument Co., Philadelphia, Pa.
International Moistening Co., Providence, R. I.
•Johnson Service Co., Milwaukee, Wis.
Johnson Tool Co., East Providence, R. I.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Moeller Instrument Co., Richmond Hill, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Palmer Co., Cincinnati (St. Bernard), O.
Rochester Mfg. Co., Inc., Rochester, N. Y.
Scientific Instrument Co., Detroit, Mich.
Standard Engineering Wks., Pawtucket, R. I.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
•Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

HYGROSTATS
See Humidistats

IMMERSION THERMOSTATS
See Thermostats, Immersion

INDICATING THERMOMETERS
See Thermometers, Indicating

INDICATOR-CONTROLLERS, RELATIVE HUMIDITY
- Bristol Co., Waterbury, Conn.
- Brown Instrument Co., Div. Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
- Foxboro Co., Foxboro, Mass.
- Johnson Service Co., Milwaukee, Wis.
- Leeds & Northrup Co., Philadelphia, Pa.
- Powers Regulator Co., Chicago, Ill.
- Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
- Taylor Instrument Companies, Rochester, N. Y.

INDICATOR-CONTROLLERS, TEMPERATURE
- Bristol Co., Waterbury, Conn.
- Brown Instrument Co., Div. Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
- Foxboro Co., Foxboro, Mass.
- Johnson Service Co., Milwaukee, Wis.
- Leeds & Northrup Co., Philadelphia, Pa.
- Powers Regulator Co., Chicago, Ill.
- Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
- Taylor Instrument Companies, Rochester, N. Y.

INDICATORS, SOUND LEVEL
- General Electric Co., Schenectady, N. Y.
- Industrial Apparatus Co., Chicago, Ill.
- Johns-Manville, New York, N. Y.

INDIRECT WATER HEATERS
See Heaters, Water, Indirect

INDUSTRIAL AIR CONDITIONERS
See Unit Air Conditioners, Industrial

INSTANTANEOUS WATER HEATERS
See Heaters, Water, Steam, Instantaneous

INSULATION, BUILDING
- Acme Asbestos Covering & Flooring Co., Chicago, Ill. (Rock wool)
- Alfol Insulation Co., New York, N. Y. (Aluminum foil)
- Alton Mineral Wool Co., Alton, Ill.
- American Flange & Mfg. Co., Inc., New York, N. Y. (Metal sheets)
- American Hair & Felt Co., Chicago, Ill. (Hair felt)
- Armstrong Cork Products Co., Lancaster, Pa. (Corkboard, fibreboard)
- Bache & Co., Semon, New York, N. Y. (Glass wool)
- Barber Co., Philadelphia, Pa.
- Berry, Jr. & Co., Inc., F. E., Framingham, Mass.
- Cabot, Inc., Samuel, Boston, Mass. (Flexible)
- Carey Co., Philip, Lockland, Cincinnati, O. (Rock wool)
- Celotex Co., Chicago, Ill.
- Chamberlin Metal Weather Strip Co., Detroit, Mich. (Rock wool)
- Certain-Teed Products Corp., New York, N. Y.
- Continental Diamond Fibre Co., Newark, Del.
- Cork Import Corp., New York, N. Y. (Cork)
- Cork Insulation Co., Inc., New York, N. Y. (Corkboard)
- Cornell Wood Products Co., Chicago, Ill.
- Eagle-Picher Lead Co., Cincinnati, O. (Mineral wool)
- Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Cork, wool, felt)
- Fir-Tex Insulating Board Co., St. Helens, Ore. (Wood fibreboard)
- General Insulating & Mfg. Co., Alexandria, Ind. (Loose fill-Blanket-Bat)
- General Insulating Products Co., Brooklyn, N. Y. (Rock wool)
- Insulite Co., Minneapolis, Minn. (Wood fibre)
- International Vermiculite Co., Springfield, Ill. (Loose fill)
- Johns-Manville, New York, N. Y. (Rock wool and wood fibreboard)
- Keasbey & Mattison Co., Ambler, Pa. (Asbestos)
- Masonite Corp., Chicago, Ill. (Fibre board)
- Mineral Felt Co., Toledo, O.
- Mineral Insulation Co., Chicago Ridge, Ill. (Rock wool)
- Mundet Cork Corp., New York, N. Y. (Cork)
- National Gypsum Co., Buffalo, N. Y.
- Norristown Magnesia & Asbestos Co., Norristown, Pa. (Rock wool, vermiculite, asbestos)
- Pacific Lumber Co., San Francisco, Cal.
- Refractory & Insulation Corp., New York, N. Y. (Rock, slag wool)
- Reynolds Corp., New York, N. Y. (Aluminum foil)
- Rock Wool Products Co., Wabash, Ind. (Loose fill)
- Ruberoid Co., New York, N. Y. (Mineral wool)
- Sprayo-Flake Co., Milwaukee, Wis.
- Standard Asbestos Mfg. Co., Chicago, Ill. (Asbestos, hairfelt)
- Standard Lime & Stone Co., Baltimore, Md. (Rock wool)
- Stone, Junius H., New York, N. Y. (Cork)
- Thermax Div., Northwest Magnesite Co., Pittsburgh, Pa. (Rigid)
- Therminsul Corp., Kalamazoo, Mich.
- Truscon Steel Co., Youngstown, O. (Insulation board sealed between metal sheets)
- U. S. Mineral Wool Co., New York, N. Y. (Mineral wool)
- Union Fibre Co., Inc., Winona, Minn. (Rock wool)
- United Cork Companies, Lyndhurst, N. J. (Cork)
- United States Gypsum Co., Chicago, Ill. (Wool and board)
- Universal Gypsum & Lime Co., Chicago, Ill. (Loose fill)
- Upson Quality Products Co., Lockport, N. Y.
- Wilson & Co., Chicago, Ill. (Board)
- Wood Conversion Co., St. Paul, Minn. (Nu-Wood board, balsam-wool blanket)

INSULATION, DUCT
- Acme Asbestos Covering & Flooring Co., Chicago, Ill. (Asbestos)
- Alfol Insulation Co., New York, N. Y. (Aluminum foil)
- American Flange & Mfg. Co., Inc., New York, N. Y. (Metal sheets)
- American Hair & Felt Co., Chicago, Ill. (Hair felt)
- Armstrong Cork Products Co., Lancaster, Pa. (Corkboard, fibreboard)
- Berry, Jr. & Co., Inc., F. E., Framingham, Mass.
- Burgess Battery Co., Chicago, Ill. (Balsam, wool)
- Cabot, Inc., Samuel, Boston, Mass. (Flexible)
- Carey Co., Philip, Lockland, Cincinnati, O. (Asbestos)
- Celotex Co., Chicago, Ill.
- Cork Import Corp., New York, N. Y. (Cork)
- Cork Insulation Co., Inc., New York, N. Y. (Corkboard)
- Eagle-Picher Lead Co., Cincinnati, O. (Mineral wool blankets)
- Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Cork, magnesia, hair felt)
- Fir-Tex Insulating Board Co., St. Helens, Ore. (Wood fibreboard)
- General Insulating & Mfg. Co., Alexandria, Ind. (Block)
- General Insulating Products Co., Brooklyn, N. Y. (Acoustic rock wool)
- Insulite Co., Minneapolis, Minn. (Wood fibre)
- International Vermiculite Co., Springfield, Ill. (Block)
- Johns-Manville, New York, N. Y. (Rock cork, asbestos)
- Keasbey & Mattison Co., Ambler, Pa. (Asbestos)
- Masonite Corp., Chicago, Ill. (Fibre board)
- Mineral Felt Co., Toledo, O.
- Mineral Insulation Co., Chicago Ridge, Ill. (Rock wool)
- Mundet Cork Corp., New York, N. Y. (Cork)
- Owens-Illinois Glass Co., Toledo, O. (Glass wool)
- Presstite Engineering Co., St. Louis, Mo. (Adhesive)
- Ruberoid Co., New York, N. Y. (Asbestos cellular and laminated sheets or blocks)
- Sall Mountain Co., Chicago, Ill. (Asbestos)
- Self-Vulcanizing Rubber Co., Inc., Chicago, Ill.
- Smith & Kanzler, Inc., Elizabeth, N. J. (Asbestos air cell type)
- Standard Asbestos Mfg. Co., Chicago, Ill. (Asbestos, hair felt)
- Thermax Div., Northwest Magnesite Co., Pittsburgh, Pa. (Rigid)
- Therminsul Corp., Kalamazoo, Mich.
- United Cork Companies, Lyndhurst, N. J. (Cork)
- Western Felt Wks., Chicago, Ill. (Felt)
- Wilson & Co., Chicago, Ill. (Flexible)
- Wood Conversion Co., St. Paul, Minn. (Balsam-wool)

INSULATION, SOUND DEADENING, CEILING AND WALL
- American Hair & Felt Co., Chicago, Ill.
- Armstrong Cork Products Co., Lancaster, Pa.
- Barber Co., Philadelphia, Pa.
- Berry, Jr., & Co., Inc., F. E., Framingham, Mass.
- Burgess Battery Co., Chicago, Ill.
- Cabot, Inc., Samuel, Boston, Mass. (Flexible)
- Celotex Co., Chicago, Ill.
- Chamberlin Metal Weatherstrip Co., Detroit, Mich. (Rock wool)
- Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Rock wool, hair felt)
- Fir-Tex Insulating Board Co., St. Helens, Ore.
- General Insulating & Mfg. Co., Alexandria, Ind.
- Johns-Manville, New York, N. Y.
- Keasbey & Mattison Co., Ambler, Pa. (Sprayed)
- Masonite Corp., Chicago, Ill. (Fibreboard)
- Mineral Felt Co., Toledo, O.
- Thermax Div., Northwest Magnesite Co., Pittsburgh, Pa. (Rigid)
- Therminsul Corp., Kalamazoo, Mich.
- Wood Conversion Co., St. Paul, Minn. (Nu-Wood, Balsam-wool)

INSULATION, SOUND DEADENING, DUCT
- American Hair & Felt Co., Chicago, Ill.
- Armstrong Cork Products Co., Lancaster, Pa.
- Berry, Jr. & Co., Inc., F. E., Framingham, Mass.
- Burgess Battery Co., Chicago, Ill.
- Cabot, Inc., Samuel, Boston, Mass. (Flexible)
- Celotex Co., Chicago, Ill.
- Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Rock wool, hair felt)
- Fir-Tex Insulating Board Co., St. Helens, Ore.
- General Insulating & Mfg. Co., Alexandria, Ind.
- Inter-Coastal Paint Corp., East St. Louis, Ill.
- Johns-Manville, New York, N. Y.
- Masonite Corp., Chicago, Ill.
- Maxim Silencer Co., Hartford, Conn.
- Mineral Felt Co., Toledo, O.

Mortell Co., J. W., Chicago, Ill.
Thermax Div., Northwest Magnesite Co., Pittsburgh, Pa. (Rigid)
Therminsul Corp., Kalamazoo, Mich.
Wilson & Co., Chicago, Ill.
Wood Conversion Co., St. Louis, Minn. (Balsam-wool)

IONIZATION APPARATUS

American Hydrozone Co., Inc., New York, N. Y.
Corozone Air Conditioning Corp., Cleveland, O.
Electroaire Corp., Chicago, Ill.
Fresh'nd-Aire Co., Chicago, Ill.
Montgomery Bros., San Francisco, Cal.
Russell Electric Co., Chicago, Ill.
United States Ozone Co. of America, Scottdale, Pa.

IRON BODY VALVES

See Valves, Gate and Valves, Globe

JOINTS, FLANGED

●Crane Co., Chicago, Ill.
Floersheim & Co., B., Pittsburgh, Pa.
●Grinnell Co., Inc., Providence, R. I.
Kellogg Co., M. W., New York, N. Y.
Limbert & Co., Geo. B., Chicago, Ill.
Lumsden Van Stone Co., South Boston, Mass.
●Midwest Piping & Supply Co., Inc., St. Louis, Mo.
National Valve & Mfg. Co., Pittsburgh, Pa.
Parks-Cramer Co., Fitchburg, Mass.
●Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.
Roessing Mfg. Co., Pittsburgh, Pa.
Sales & Co., Murray W., Detroit, Mich.
Semet-Solvay Engineering Corp., New York, N. Y.
Shaw Co., Benjamin F., Wilmington, Del.
Taylor Forge & Pipe Wks., Chicago, Ill.
●Walworth Co., New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.

JOINTS, PIPE, EXPANSION

●American District Steam Co., North Tonawanda, N. Y.
Badger & Sons Co., E. B., Boston, Mass. (Corrugated copper, stainless steel)
Badger Fire Extinguisher Co., Boston, Mass.
Barco Mfg. Co., Chicago, Ill.
Belfield Co., H., Philadelphia, Pa.
Bordo Co., Inc., L. J. Glenside, Pa.
Central Station Steam Co., Detroit, Mich.
Chase Brass & Copper Co., Waterbury, Conn.
●Crane Co., Chicago, Ill.
Croll-Reynolds Engineering Co., Inc., New York, N. Y.
Dresser Mfg. Co., S. R., Bradford, Pa.
Floersheim & Co., B., Pittsburgh, Pa.
Harris & Co., Arthur, Chicago, Ill.
Howard Iron Wks. & Alberger Heater Co., Buffalo, N .Y.
Illinois Engineering Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Kopperman & Sons, Joseph B., Philadelphia, Pa.
Limbert & Co., Geo. B., Chicago, Ill.
Lumsden Van Stone Co., South Boston, Mass.
National Valve & Mfg. Co., Pittsburgh, Pa.
Northern Indiana Brass Co., Elkhart, Ind.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Seamlex Co., Long Island City, N. Y. (Flexible, seamless)
Semet-Solvay Engineering Corp., New York, N. Y.
United States Rubber Products, Inc., New York, N. Y. (Rubber)
Victaulic Co. of America, New York, N. Y.
●Walworth Co. New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.
●Yarnall-Waring Co., Philadelphia, Pa.

LEAD PIPE

See Pipe, Lead

LEAD SHEETS

See Sheets, Lead

LEAK DETECTORS

See Detectors, Leak, Refrigerant

LEATHER BELTING

See Belting, Leather

LEATHER PACKING

See Packing, Leather

LIQUID LEVEL GAGES

See Gages, Liquid Level

LIQUID LEVEL RECORDERS

See Recorders, Liquid Level

LIQUID PRESSURE REGULATORS

See Regulators, Pressure, Liquid

LOUVERS AND SHUTTERS

American Foundry & Furnace Co., Bloomington, Ill.
American Warming & Ventilating Co., Toledo, O.
Arex Co., Chicago, Ill.
●Autovent Fan & Blower Co., Chicago, Ill.
Champion Blower & Forge Co., Lancaster, Pa.
Chicago Metal Mfg. Co., Chicago, Ill.
Elgo Shutter & Mfg. Co., Detroit, Mich.
Kirk & Blum Mfg. Co., Cincinnati, O.
Kleenaire Corp., Stevens Point, Wis.
Robertson Co., H. H., Pittsburgh, Pa.
Strandwitz & Co., Inc., Camden, N. J.
Utility Fan & Mfg. Co., Los Angeles, Cal.
Viking Air Conditioning Corp., Cleveland, O.
●Waterloo Register Co., Waterloo, Ia.
White Co., Kelvin & Wilfred B., Boston, Mass.

LUBRICATING OIL

See Oil, Lubricating

MACHINES AND FILM, X-RAY

Eastman Kodak Co., Rochester, N. Y.
Kelly-Koet, Covington, Ky.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MACHINES, PIPE CUTTING AND THREADING, PORTABLE

Air Reduction Sales Co., New York, N. Y. (Cutting and beveling)
American Die & Tool Co., Reading, Pa.
Beaver Pipe Tools, Inc., Warren, O.
Curtis & Curtis Co., Bridgeport, Conn.
Landis Machine Co., Inc., Waynesboro, Pa
Nye Tool & Machine Wks., Chicago, Ill.
●Oster Mfg. Co., Cleveland, O.
Peerless Mach. Co., Racine, Wis.
●Ridge Tool Co., Elyria, O. (Hand)
Toledo Pipe Threading Machine Co., Toledo, O.

MACHINES, PIPE CUTTING AND THREADING, STATIONARY

American Die & Tool Co., Reading, Pa.
Beaver Pipe Tools, Inc., Warren, O.
Bignall & Keeler Machine Wks., Edwardsville, Ill.
●Bullard Co., Bridgeport, Conn. (Vertical, threading & boring)
Curtis & Curtis Co., Bridgeport, Conn.
Jarecki Mfg. Co., Erie, Pa.
Landis Machine Co., Inc., Waynesboro, Pa.
Merrell Mfg. Co., Toledo, O.
●Oster Mfg. Co., Cleveland, O.
Saunders Sons, Inc., D., Yonkers, N. Y.
Toledo Pipe Threading Machine Co., Toledo, O.

MALLEABLE UNIONS

See Unions, Malleable

MANOMETERS

A. C. E. Inc., Chicago, Ill.
American Blower Corp., Detroit, Mich.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Consolidated Ashcroft Hancock Co., Bridgeport, Conn.
Defender Automatic Regulator Co., St. Louis, Mo.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
Morey & Jones, Ltd., Los Angeles, Cal.
Republic Flow Meters Co., Chicago, Ill.
Scientific Instrument Co., Detroit, Mich.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

MECHANICAL DRIVE TURBINES

See Turbines, Mechanical Drive

MECHANICAL TRAPS

See Traps, Steam, Mechanical

METALLIC PACKING

See Packing, Metallic

METERS, CONDENSATION

●American District Steam Co., North Tonawanda, N. Y.
Buffalo Meter Co., Buffalo, N. Y.
Central Station Steam Co., Detroit, Mich.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Worthington-Gamon Meter Co., Harrison, N. J.

METERS, FLOW, PROCESS LIQUID

Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadephia, Pa.
Buffalo Meter Co., Buffalo, N. Y.
Foxboro Co. Foxboro, Mass.
Mason-Neilan Regulator Co., Boston, Mass.
Morey & Jones, Ltd., Los Angeles, Cal.
Republic Flow Meters Co., Chicago, Ill.
Spray Engineering Co., Somerville, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

METERS, FLOW, STEAM

●American District Steam Co., North Tonawanda, N. Y.
American Meter Co., New York, N. Y.
Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Cochrane Corp., Philadelphia, Pa.
Elgin Softener Corp., Elgin, Ill.

Foxboro Co., Foxboro, Mass.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Morey & Jones, Ltd., Los Angeles, Cal.
Republic Flow Meters Co., Chicago, Ill.
Schutte & Koerting Co., Philadelphia, Pa.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

METERS, WATER

Bailey Meter Co., Cleveland, O.
Buffalo Meter Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
Foxboro Co., Foxboro, Mass.
National Meter Co., Brooklyn, N. Y.
Neptune Meter Co., New York, N. Y.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Republic Flow Meters Co., Chicago, Ill.
Union Water Meter Co., Worcester, Mass.
Worthington-Gamon Meter Co., Harrison, N. J.

MIXING VALVES

See Valves, Mixing, Steam and Water

MODULATING VALVES

See Valves, Radiator, Steam and Hot Water

MOTOR BASES

See Bases, Vibration Isolating

MOTOR CONTROLLERS

See Controllers and Starters, Motor

MOTOR-OPERATED VALVES

See Valves, Motor-operated

MOTOR STARTERS

See Controllers and Starters, Motor

MOTORS, ELECTRIC, FRACTIONAL HP

Baldor Electric Co., St. Louis, Mo.
●Barber-Colman Co., Rockford, Ill.
Black & Decker Mfg. Co., Towson, Md.
Bodine Electric Co., Chicago, Ill.
Brown-Brockmeyer Co., Dayton, O.
Burke Electric Co., Erie, Pa.
●Century Electric Co., St. Louis, Mo.
Delco Products Corp., Dayton, O.
Diehl Mfg. Co., Elizabethport, N. J.
Emerson Electric Mfg. Co., St. Louis, Mo.
●Fairbanks, Morse & Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
●Holtzer-Cabot Electric Co., Boston, Mass.
Howell Electric Motors Co., Howell, Mich.
Janette Mfg. Co., Chicago, Ill.
●Leland Electric Co., Dayton, O.
Marathon Electric Mfg. Corp., Wausau, Wis.
Master Electric Co., Dayton, O.
Ohio Electric Mfg. Co., Cleveland, O.
Peerless Electric Co., Warren, O.
Robbins & Myers, Inc., Springfield, O.
Russell Electric Co., Chicago, Ill.
Speedway Mfg. Co., Chicago (Cicero), Ill.
Star Electric Motor Co., Bloomfield, N. J.
Sterling Electric Motors, Inc., Los Angeles, Cal.
●Sturtevant Co., B. F., Boston, Mass.
U. S. Electrical Motors, Inc., Los Angeles, Cal.
●Wagner Electric Corp., St. Louis, Mo.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOTORS, ELECTRIC, 1 HP AND OVER

Allis Co., Louis, Milwaukee, Wis.
●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Baldor Electric Co., St. Louis, Mo.
Brown-Brockmeyer Co., Dayton, O.
Burke Electric Co., Erie, Pa.
●Century Electric Co., St. Louis, Mo.
Continental Electric Co., Inc., Newark, N. J.
Crocker-Wheeler Elec. Mfg. Co., Ampere, N. J.
Delco Products Corp., Dayton, O.
Diehl Mfg. Co., Elizabethport, N. J.
Electric Machinery Mfg. Co., Minneapolis, Minn.
Elliott Co., Jeanette, Pa.
Emerson Electric Mfg. Co., St. Louis, Mo.
●Fairbanks, Morse & Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee, Wis.
●Holtzer-Cabot Electric Co., Boston, Mass. (2 & less)
Howell Electric Motors Co., Howell, Mich.
Ideal Electric & Mfg. Co., Mansfield, O.
Imperial Electric Co., Akron, O.
Janette Mfg. Co., Chicago, Ill.
●Leland Electric Co., Dayton, O.
Lincoln Electric Co., Cleveland, O.
Marble-Card Electric Co., Gladstone, Mich.
Master Electric Co., Dayton, O.
Peerless Electric Co., Warren, O.
Philadelphia Gear Co., Philadelphia, Pa. (Geared)
Reliance Electric & Engineering Co., Cleveland, O.
Robbins & Myers, Inc., Springfield, O.
Star Electric Motor Co., Bloomfield, N. J.
Sterling Electric Motors, Inc., Los Angeles, Cal.
●Sturtevant Co., B. F., Boston, Mass.
Triumph Ice Machine Co., Cincinnati, O.
U. S. Electrical Motors, Inc., Los Angeles, Cal.
●Wagner Electric Corp., St. Louis, Mo.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zobell Electric Motor Corp., Garwood, N. J.

MUSHROOM VENTILATORS

See Ventilators, Mushroom

NEEDLE VALVES

See Valves, Needle

NIPPLES, PIPE, BRASS AND COPPER

Acheson Mfg. Co., Rankin, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
Chicago Nipple Mfg. Co., Chicago, Ill.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
●Grinnell Co., Inc., Providence, R. I.
Imperial Brass Mfg. Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
Phoenix Brass Fittings Corp., Irvington, N. J.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Shaw-Kendall Engineering Co., Toledo, O.
●Walworth Co., New York, N. Y.
Weatherhead Co., Cleveland, O.

NIPPLES, PIPE, IRON AND STEEL

Byers Co., A. M., Pittsburgh, Pa. (Wrought iron)
Chicago Nipple Mfg. Co., Chicago, Ill.
Cohoes Rolling Mill Co., Cohoes, N. Y.
●Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
Dresser Mfg. Co., S. R., Bradford, Pa.
●Grinnell Co., Inc., Providence, R. I.
Jarecki Mfg. Co., Erie, Pa.
Penn Mfg. Corp. of Washington, Pa., Washington, Pa.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Reading Iron Co., Philadelphia, Pa.
Shaw-Kendall Engineering Co., Toledo, O.
●Walworth Co., New York, N. Y.

NOZZLES, SPRAY

Balloffet Diamond Wire Dies Co., Guttenberg, N. J.
Bayley Blower Co., Milwaukee, Wis.
●Binks Mfg. Co., Chicago, Ill.
Blower Application Co., Milwaukee, Wis.
●Buffalo Forge Co., Buffalo, N. Y.
Chain Belt Co., Milwaukee, Wis.
Cooling Tower Co., Inc., New York, N. Y.
●Detroit Lubricator Co., Detroit, Mich.
Goodrich Co., B. F., Akron, O.
Howell Mfg. Co., Kansas City, Mo.
International Moistening Co., Providence, R. I.
●Marley Co., Kansas City, Mo.
Martocello & Co., Jos. A., Philadelphia, Pa.
●Monarch Mfg. Wks., Inc., Philadelphia, Pa.
Northern Indiana Brass Co., Elkhart, Ind.
Parks-Cramer Co., Fitchburg, Mass.
Penn Cooling Tower Wks., Pittsburgh, Pa.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Rega Mfg. Co., Rochester, N. Y.
Ross Sprinkler Co., Pasadena, Cal.
Schubert-Christy Corp., Affton, Mo.
Schutte & Koerting Co., Philadelphia, Pa.
Skinner Irrigation Co., Troy, O.
Spray Engineering Co., Somerville, Mass.
Strandwitz & Co., Inc., Camden, N. J.
●Sturtevant Co., B. F., Boston, Mass.
●Yarnall-Waring Co., Philadelphia, Pa.
●York Ice Machinery Corp., York, Pa

ODOR ADSORBERS

See Filters, Air

OIL BURNERS

See Burners, Oil

OIL, LUBRICATING

●Frick Co., Waynesboro, Pa.
Houghton & Co., E. F., Philadelphia, Pa.
Indian Refining Co., Indianapolis, Ind.
Marathon Oil Co., Tulsa, Okla.
Mid-Continent Petroleum Corp., Tulsa, Okla.
Sinclair Refining Co., New York, N. Y.
Standard Oil Co. of California, San Francisco, Cal.
Standard Oil Co. of Indiana, Chicago, Ill.
Texas Co., New York, N. Y.
●York Ice Machinery Corp., York, Pa.

OIL SEPARATORS

See Separators, Steam and Oil

OPERATORS, DAMPER, DUCT

●Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
●Barber-Colman Co., Rockford, Ill.
Cooper Co., Clark, Philadelphia, Pa.
●Detroit Lubricator Co., Detroit, Mich.
●General Controls Co., San Francisco, Cal.
●Johnson Service Co., Milwaukee, Wis.
Mercoid Corp., Chicago, Ill.

●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
●Taylor Instrument Companies, Rochester, N. Y.

OPERATORS, VALVE

Automatic Temperature Control Co., Inc., Philadelphia, Pa.
●Barber-Colman Co., Rockford, Ill.
Cooper Co., Clark, Philadelphia, Pa.
●Detroit Lubricator Co., Detroit, Mich.
●General Controls Co., San Francisco, Cal.
General Electric Co., Schenectady, N. Y.
●Johnson Service Co., Milwaukee, Wis.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
●Taylor Instrument Companies, Rochester, N. Y.

OXY-ACETYLENE WELDING

See Welding and Cutting Apparatus, Oxy-Acetylene

OZONE APPARATUS

American Hydrozone Co., Inc., New York, N. Y.
Corozone Air Conditioning Corp., Cleveland, O.
Electroaire Corp., Chicago, Ill.
Fresh'nd-Aire Co., Chicago, Ill.
Montgomery Bros., San Francisco, Cal.
Norwood Engineering Co., Florence, Mass.
Russell Electric Co., Chicago, Ill.
Triox Engineering Co., St. Louis, Mo.
United States Ozone Co. of America, Scottdale, Pa.

PACKING, ASBESTOS

Acme Asbestos Covering & Flooring Co., Chicago, Ill.
Allpax Co., Inc., Mamaroneck, N. Y.
Anchor Packing Co., Philadelphia, Pa.
Austin-Mason Co., New York, N. Y.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Carey Co., Philip, Lockland, Cincinnati, O.
Chicago Specialty Mfg. Co., Chicago, Ill.
Crandall Packing Co., Palmyra, N. Y.
Crane Packing Co., Chicago, Ill.
Darcoid Co., Inc., New York, N. Y.
Durabla Mfg. Co., New York, N. Y.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.
Goodrich Co., B. F., Akron, O.
Greene, Tweed & Co., New York, N. Y.
Jenkins Bros., New York, N. Y.
Johns-Manville, New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Klingerit, Inc., New York, N. Y. (Sheet & rod)
Metallo Gasket Co., New Brunswick, N. J.
Sall Mountain Co., Chicago, Ill.
United States Rubber Products, Inc., New York, N. Y.
Williams Gauge Co., Pittsburgh, Pa.

PACKING, FIBRE

Anchor Packing Co., Philadelphia, Pa.
Austin-Mason Co., New York, N. Y.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Crandall Packing Co., Palmyra, N. Y.
Darcoid Co., Inc., New York, N. Y.
Durabla Mfg. Co., New York, N. Y.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Endura Mfg. Corp., Quakertown, Pa.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.
Johns-Manville, New York, N. Y.
Metallo Gasket Co., New Brunswick, N. J.
Union Fibre Co., Inc., Winona, Minn.

PACKING, LEATHER

Belmont Packing & Rubber Co., Philadelphia, Pa.
Chicago Belting Co., Chicago, Ill.
Crandall Packing Co., Palmyra, N. Y.
Graton & Knight Co., Worcester, Mass.
●Rhoads & Sons, J. E., Wilmington, Del.
●Watson-Stillman Co., Roselle, N. J.

PACKING, METALLIC

Allpax Co., Inc., Mamaroneck, N. Y.
Anchor Packing Co., Philadelphia, Pa.
Austin-Mason Co., New York, N. Y.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Conneaut Packing Co., Conneaut, O.
Crandall Packing Co., Palmyra, N. Y.
Crane Packing Co., Chicago, Ill.
Darcoid Co., Inc., New York, N. Y.
France Packing Co., Tacony, Philadelphia, Pa.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.
Hound Packing Co., Chicago, Ill.
Johns-Manville, New York, N. Y.
Klingerit, Inc., New York, N. Y. (Sheet & rod)
Rotary Seal Co., Chicago, Ill.
United States Rubber Products, Inc., New York, N. Y.
Williams Gauge Co., Pittsburgh, Pa.

PACKING, RUBBER

Akron Metallic Gasket Co., Akron, O.
Anchor Packing Co., Philadelphia, Pa.
Austin-Mason Co., New York, N. Y.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Chicago Specialty Mfg. Co., Chicago, Ill.
Continental Rubber Wks., Erie, Pa.
Crandall Packing Co., Palmyra, N. Y.
Crane Packing Co., Chicago, Ill.
Darcoid Co., Inc., New York, N. Y.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Garlock Packing Co., Palmyra, N. Y.
Goodrich Co., B. F., Akron, O.
Goodyear Tire & Rubber Co., Akron, O.
Hamilton Rubber Mfg. Co., Trenton, N. J.
Houghton & Co., E. F., Philadelphia, Pa.
Jenkins Bros., New York, N. Y.
Johns-Manville, New York, N. Y.
Manhattan Rubber Mfg. Co., Div. of Raybestos-Manhattan, Inc., Passaic, N. J.
Republic Rubber Co., Youngstown, O.
United States Rubber Products, Inc., New York, N. Y.

PARTS, PRESSED SHEET METAL

Berger Mfg. Co., Div. of Republic Steel Corp., Canton, O.
Bossert Corp., Utica, N. Y.
Geuder, Paeschke & Frey Co., Milwaukee, Wis.
Martin-Parry Corp., York, Pa.
Mullins Mfg. Corp., Salem, O.
U. S. Pressed Steel Products Co., Kalamazoo, Mich.
Utica Products, Inc., Utica, N. Y.
Youngstown Pressed Steel Co., Warren, O.

PILLOW BLOCKS

See Blocks, Pillow

PIPE, ALLOY

Allegheny Steel Co., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
●American Brass Co., Waterbury, Conn.
Antaciron, Inc., Raritan, N. J.
Babcock & Wilcox Co., New York, N. Y.
Bethlehem Steel Co., Bethlehem, Pa.
Duraloy Co., Pittsburgh, Pa.
Duriron Co., Inc., Dayton, O.
International Nickel Co., New York, N. Y.
●National Tube Co., Pittsburgh, Pa.
●Republic Steel Corp., Cleveland, O.
●Revere Copper & Brass, Inc., New York, N. Y.
Spang, Chalfant & Co., Inc., Pittsburgh, Pa.
●Wheeling Steel Corp., Wheeling, W. Va.

PIPE, ASBESTOS FIBRE AND CEMENT

Allen-Sherman-Hoff Co., Philadelphia, Pa.
Carey Co., Philip, Lockland, Cincinnati, O.
Continental Diamond Fibre Co., Newark, Del. (Fibre, bakelite)
Johns-Manville, New York, N. Y.
●Ric-Wil Co., Cleveland, O.
Sall Mountain Co., Chicago, Ill.

PIPE BENDERS

See Benders, Conduit and Pipe

PIPE, BRASS AND COPPER

●American Brass Co., Waterbury, Conn.
●American Radiator Co., New York, N. Y.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
●Crane Co., Chicago, Ill.
●Revere Copper & Brass Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
●Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
United States Brass & Copper Co., Hyde Park, Boston, Mass.
Wolverine Tube Co., Detroit, Mich.

PIPE, CAST IRON, PRESSURE, BELL AND SPIGOT

Alabama Pipe Co., Anniston, Ala.
American Cast Iron Pipe Co., Birmingham, Ala.
Central Foundry Co., New York, N. Y.
Clow & Sons, James B., Chicago, Ill.
●Crane Co., Chicago, Ill.
Lynchburg Foundry Co., Lynchburg, Va.
McWane Cast Iron Pipe Co., Birmingham, Ala.
U. S. Pipe & Fdry. Co., Burlington, N. J.
Warren Foundry & Pipe Corp., New York, N. Y.

PIPE, CAST IRON, PRESSURE, FLANGED

Alabama Pipe Co., Anniston, Ala.
American Cast Iron Pipe Co., Birmingham, Ala.
Central Foundry Co., New York, N. Y.
Clow & Sons, James B., Chicago, Ill.
●Crane Co., Chicago, Ill.
McWane Cast Iron Pipe Co., Birmingham, Ala.
U. S. Pipe & Fdry. Co., Burlington, N. J.
●Walworth Co., New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.

PIPE, CAST IRON, THREADED

American Cast Iron Pipe Co., Birmingham, Ala.
●American Radiator Co., New York, N. Y.
Clow, Jas. B. & Sons, Chicago, Ill.
●Crane Co., Chicago, Ill.

Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill. (Steam-jacketed)
McWane Cast Iron Pipe Co., Birmingham, Ala.
Somerville Iron Wks., Somerville, N. J.
U. S. Pipe & Foundry Co., Burlington, N. J.
●Walworth Co., New York, N. Y.
Warren Foundry & Pipe Corp., New York, N. Y.

PIPE COUPLINGS
See Couplings, Pipe

PIPE COVERING
See Covering, Pipe

PIPE CUTTERS
See Cutters, Pipe and Tubing

PIPE CUTTING MACHINES
See Machines, Pipe Cutting and Threading

PIPE FITTINGS
See Fittings, Pipe

PIPE FLANGES
See Flanges, Pipe

PIPE, GLASS
Corning Glass Wks., Corning, N. Y.

PIPE HANGERS
See Hangers and Supports, Pipe

PIPE JOINT COMPOUNDS
See Cement and Compounds, Pipe Joint

PIPE, LEAD
Andrews Lead Co., Long Island City, N. Y.
Belmont Smelting & Refining Wks., Inc., Brooklyn, N. Y.
Eagle-Picher Lead Co., Cincinnati, O.
Flemm Lead Co., Inc., Long Island City, N. Y.
Lissberger & Son, Inc., Marks, Long Island City, N. Y.
National Lead Co., New York, N. Y.

PIPE, LINED
American Cast Iron Pipe Co., Birmingham, Ala. (Cement)
American Hard Rubber Co., New York, N. Y. (Rubber)
Cohoes Rolling Mill Co., Cohoes, N. Y. (Cement)
Goodrich Co., B. F., Akron, O. (Rubber-lined)
Lead Lined Iron Pipe Co., Wakefield, Mass. (Lead and tin lined)
Manhattan Rubber Mfg. Co., Div. of Raybestos-Manhattan, Inc., Passaic, N. J. (Rubber)
National Lead Co., New York, N. Y. (Lead)
●National Tube Co., Pittsburgh, Pa. (Cement)
Pfaudler Co., Rochester, N. Y. (Glass lined)
Public Works Supply Co., Lynn, Mass. (Cement)
●Republic Steel Corp., Cleveland, O. (Cement lined)
Resisto Pipe & Valve Co., East Cambridge, Mass. (Lead)
United States Rubber Products, Inc., New York, N. Y. (Rubber)
Vitreous Enameling & Stamping Co., New York, N. Y. (Enamel)
Warren Foundry & Pipe Corp., New York, N. Y.

PIPE LINE STRAINERS
See Strainers, Pipe Line

PIPE NIPPLES
See Nipples, Pipe, Wrought

PIPE REAMERS
See Reamers, Pipe

PIPE REPAIR CLAMPS
See Clamps, Pipe Repair

PIPE, SEAMLESS, STEEL
Babcock & Wilcox Co., New York, N. Y.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
●National Tube Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Spang, Chalfant & Co., Inc., Pittsburgh, Pa.
●Timken Steel & Tube Co., Canton, O.
●Youngstown Sheet & Tube Co., Youngstown, O.

PIPE, SPIRAL, RIVETED AND WELDED
Abendroth & Root Mfg. Co., Newburgh, N. Y.
●American Rolling Mill Co., Middletown, O.
Naylor Pipe Co., Chicago, Ill.
Taylor Forge & Pipe Wks., Chicago, Ill.

PIPE, STEEL
●American Rolling Mill Co., Middletown, O.
Bethlehem Steel Co., Bethlehem, Pa.
Byers Co., A. M., Pittsburgh, Pa.
Central Tube Co., Pittsburgh, Pa.
Cohoes Rolling Mill Co., Cohoes, N. Y.
●Fretz-Moon Tube Co., Butler, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Laclede Steel Co., St. Louis, Mo.
Mark & Co., Clayton, Chicago, Ill.
●National Tube Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Pittsburgh Tube Co., Pittsburgh, Pa.
●Republic Steel Corp., Cleveland, O.
South Chester Tube Co., Chester, Pa.
Spang, Chalfant & Co., Pittsburgh, Pa.
Wheatland Tube Co., Philadelphia, Pa.
●Wheeling Steel Corp., Wheeling, W. Va.
●Youngstown Sheet & Tube Co., Youngstown, O.

PIPE SUPPORTS
See Hangers and Supports, Pipe

PIPE TONGS
See Tongs, Pipe

PIPE VISES
See Vises, Pipe

PIPE, WOOD
●American District Steam Co., No. Tonawanda, N. Y.
Caldwell Co., W. E., Louisville, Ky.
Michigan Pipe Co., Bay City, Mich.
National Wood Products Co., Hughesville, Pa.
Wyckoff & Son Co., A., Elmira, N. Y.

PIPE WRENCHES
See Wrenches, Pipe

PIPE, WROUGHT IRON
Byers Co., A. M., Pittsburgh, Pa.
Cohoes Rolling Mill Co., Cohoes, N. Y.
Reading Iron Co., Philadelphia, Pa.
South Chester Tube Co., Chester, Pa.

PIPE AND FITTINGS, HARD RUBBER
American Hard Rubber Co., New York, N. Y.
Goodrich Co., B. F., Akron, O.
Luzerne Rubber Co., Trenton, N. J. (Hard rubber)
Stokes Rubber Co., Jos., Trenton, N. J.
United States Rubber Products, Inc., New York, N. Y.

PIPE AND FITTINGS, STONEWARE
General Ceramics Co., New York, N. Y.
Knight, Maurice A., Akron, O. (Stoneware)
U. S. Stoneware Co., New York, N. Y. (Stoneware)

PIPING, FABRICATED
See Bends, Headers, Joints, etc.

PLATES, FLOOR AND CEILING
●American Radiator Co., New York, N. Y.
Beaton & Cadwell Mfg. Co., New Britain, Conn.
Beaton & Corbin Mfg. Co., Southington, Conn.
Chicago Nipple Mfg. Co., Chicago, Ill.
Farley Sleeve & Hanger Co., Cleveland, O.
Globe Machine & Stamping Co., Cleveland, O.
Keeney Mfg. Co., Newington, Conn.
Little Mfg. Co., M. S., Hartford, Conn.
Pittsburgh Valve & Fittings Corp., Barberton, O.

PLUG COCKS
See Valves, Plug

PLUG VALVES
See Valves, Plug

POWER SHEARS
See Shears, Power

PREHEATERS, FUEL OIL
Bell & Gossett Co., Chicago, Ill.
Davis Engineering Corp., Elizabeth, N. J.
General Fittings Co., Providence, R. I.
Griscom-Russell Co., New York, N. Y.
Johnson Co., S. T., Oakland, Cal.
Johnson Corp., Three Rivers, Mich.
National Pipe Bending Co., New Haven, Conn.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Taco Heaters, Inc., Brooklyn, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.
●Wiegand Co., Edwin L., Pittsburgh, Pa.

PRESSURE BLOWERS
See Blowers, Pressure

PRESSURE GAGES
See Gages, Pressure

PRESSURE RECORDERS
See Recorders, Pressure

PRESSURE REDUCING VALVES
See Valves, Pressure Reducing and Regulating

PRESSURE REGULATING VALVES
See Valves, Pressure Reducing and Regulating

PRESSURE REGULATORS
See Regulators, Pressure

PRESSURE SWITCHES
See Switches, Pressure and Vacuum

PROPELLER FANS
See Fans, Propeller

PROTECTORS, PIPE COVERING
Carpenter & Paterson, Inc., East Boston, Mass.
Cheney Co., Winchester, Mass.

PSYCHROMETERS, RECORDING
A. C. E. Inc., Chicago, Ill.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Julien P., Baltimore, Md.

H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Moeller Instrument Co., Richmond Hill, N. Y.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

PSYCHROMETERS, SLING

A. C. E. Inc., Chicago, Ill.
American Moistening Co., Providence, R. I.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
G. M. Mfg. Co., New York, N. Y.
H-B Instrument Co., Philadelphia, Pa.
●Johnson Service Co., Milwaukee, Wis.
Moeller Instrument Co., Richmond Hill, N. Y.
Palmer Co., Cincinnati (St. Bernard), O.
Parks-Cramer Co., Fitchburg, Mass.
●Taylor Instrument Companies, Rochester, N. Y.

PSYCHROSTATS

See Humidistats

PUMP BASES

See Bases, Vibration Isolating

PUMPS, AIR

Beach-Russ Co., New York, N. Y.
Brunner Mfg. Co., Utica, N. Y.
Chicago Pneumatic Tool Co., New York, N. Y.
●Curtis Refrigerating Machine Co., St. Louis, Mo.
Davidson Co., M. T., New York, N. Y.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Fuller Co., Catasauqua, Pa.
Gardner-Denver Co., Quincy, Ill.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Ingersoll-Rand, New York, N. Y.
Kellogg Compressor & Mfg. Corp., Rochester, N. Y.
Leiman Bros., Inc., Newark, N. J.
Martocello & Co., Jos. A., Philadelphia, Pa.
McGowan Co., John H., Cincinnati, O.
●Nash Engineering Co., South Norwalk, Conn.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Roots-Connersville Blower Corp., Connersville, Ind.
Skidmore Corp., St. Joseph, Mich.
Trimount Rotary Power Co., East Dedham, Mass.
Uniflow Mfg. Co., Erie, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, BOILER FEED

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
Austin-Mason Co., New York, N. Y.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Cissell Mfg. Co., W. M., Louisville, Ky.
Columbus Steam Pump Wks. Co., Columbus, O.
Davidson Co., M. T., New York, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Dean Hill Pump Co., Anderson, Ind.
Decatur Pump Co., Decatur, Ill.
●Deming Co., Salem, O.
Eclipse Fuel Engineering Co., Rockford, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
Foster Wheeler Corp., New York, N. Y.
Gardner-Denver Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
●Ingersoll-Rand, New York, N. Y.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Lecourtenay Co., Newark, N. Y.
Micro-Westco, Inc., Bettendorf, Ia.
●Nash Engineering Co., South Norwalk, Conn.
Roots-Connersville Blower Corp., Connersville, Ind.
Rumsey Pump Corp., Seneca Falls, N. Y.
Schaub Engineering Co., Fred H., Chicago, Ill.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
Weil Pump Co., Chicago, Ill.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, CENTRIFUGAL

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
American Well Wks., Aurora, Ill.
Austin-Mason Co., New York, N. Y.
Barrett, Haentjens & Co., Hazelton, Pa.
Beach-Russ Co., New York.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Chain Belt Co., Milwaukee, Wis.
Chicago Pump Co., Chicago, Ill.
Columbus Steam Pump Wks. Co., Columbus, O.
Davidson Co., M. T., New York, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Dean Bros. Co., Indianapolis, Ind.
Dean Hill Pump Co., Anderson, Ind.
Decatur Pump Co., Decatur, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
●Deming Co., Salem, O.
Domestic Engine & Pump Co., New York, N. Y.
●Dunham Co., C. A., Chicago, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
Foster Wheeler Corp., New York, N. Y.
Fulflo Specialties Co., Blanchester, O.
Gardner-Denver Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Ingersoll-Rand, New York, N. Y.
Jackson Co., Byron, Berkeley, Cal.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
La Bour Pump Co., Inc., Elkhart, Ind.
Lawrence Pump & Engine Co., Lawrence, Mass.
Lecourtenay Co., Newark, N. J.
Lewis & Co., Inc., Chas. S., St. Louis, Mo.
McGowan Co., John H., Cincinnati, O.
Micro-Westco, Inc., Bettendorf, Ia.
Morris Machine Wks., Baldwinsville, N. Y.
Myers & Bro. Co., F. E., Ashland, O.
●Nash Engineering Co., South Norwalk, Conn.
Oberdorfer Brass Co., M. L., Syracuse, N. Y.
Palmer Electric Co., Detroit, Mich.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Quimby Pump Co., Inc., Newark, N. J.
Rumsey Pump Corp., Seneca Falls, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Schwitzer-Cummins Co., Indianapolis, Ind.
Swaby Mfg. Co., Chicago, Ill.
Taber Pump Co., Buffalo, N. Y.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
Weil Pump Co., Chicago, Ill.
Weinman Pump Mfg. Co., Columbus, O.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, CONDENSATION RETURN

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American District Steam, North Tonawanda, N. Y.
●American Radiator Co., New York, N. Y.
●American Steam Pump Co., Battle Creek, Mich.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Chicago Pump Co., Chicago, Ill.
Cissell Mfg. Co., W. M., Louisville, Ky.
Davidson Co., M. T., New York, N. Y.
Columbus Steam Pump Wks. Co., Columbus, O.
Dayton-Dowd Co., Quincy, Ill.
Dean Hill Pump Co., Anderson, Ind.
Decatur Pump Co., Decatur, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
●Deming Co., Salem, O.
Domestic Engine & Pump Co., New York, N. Y.
●Dunham Co., C. A., Chicago, Ill.
Eclipse Fuel Engineering Co., Rockford, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
Foster Wheeler Corp., New York, N. Y.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
●Ingersoll-Rand, New York, N. Y.
Jackson Co., Byron, Berkeley, Cal.
Johnson Corp., Three Rivers, Mich.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Lecourtenay Co., Newark, N. J.
Lewis & Co., Inc., Chas. S., St. Louis, Mo.
McGowan Co., John H., Cincinnati, O.
Micro-Westco, Inc., Bettendorf, Ia.
Myers & Bro. Co., F. E., Ashland, O.
●Nash Engineering Co., South Norwalk, Conn.
National Steam Pump Co., Upper Sandusky, O.
Oberdorfer Brass Co., M. L., Syracuse, N. Y.
Quimby Pump Co., Inc., Newark, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Rumsey Pump Corp., Seneca Falls, N. Y.
Schaub Engineering Co., Fred H., Chicago, Ill.
Skidmore Corp., St. Louis, Mich.
Sterling Engineering Co., Milwaukee, Wis.
Swaby Mfg. Co., Chicago, Ill.
Weil Pump Co., Chicago, Ill.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, DEEP WELL

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
American Well Wks., Aurora, Ill.
Columbus Steam Pump Wks., Columbus, O.
●Crane Co., Chicago, Ill.
Davidson Co., M. T., New York, N. Y.
Decatur Pump Co., Decatur, Ill.
●Deming Co., Salem, O.
●Fairbanks, Morse & Co., Chicago, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
●Ingersoll-Rand, New York, N. Y.
●Layne & Bowler, Inc., Memphis, Tenn.
Myers & Bro. Co., F. E., Ashland, O.
Micro-Westco, Inc., Bettendorf, Ia.
●Pomona Pump Co., Pomona, Cal.
Red Jacket Pump Co., Davenport, Ia.

Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Corp., Seneca Falls, N. Y.
Uniflow Mfg. Co., Erie, Pa.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, FIRE

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
●Ingersoll-Rand, New York, N. Y.
Lecourtenay Co., Newark, N. J.
Morris Machine Wks., Baldwinsville, N. Y.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Rumsey Pump Corp., Seneca Falls, N. Y.
Viking Pump Co., Cedar Falls, Ia.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, HYDRAULIC

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
American Well Wks., Aurora, Ill.
Austin-Mason Co., New York, N. Y.
Bishop & Babcock Sales Co., Cleveland, O.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Davidson Co., M. T., New York, N. Y.
Goulds Pumps, Inc., Seneca Falls, N. Y.
●Ingersoll-Rand, New York, N. Y.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Corp., Seneca Falls, N. Y.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
Viking Pump Co., Cedar Falls, Ia.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, RECIPROCATING

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
Austin-Mason Co., New York, N. Y.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Columbus Steam Pump Wks., Columbus, O.
Davidson Co., M. T., New York, N. Y.
●Deming Co., Salem, O.
Domestic Engine & Pump Co., New York, N. Y.
●Fairbanks-Morse & Co., Chicago, Ill.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Gardner-Denver Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
●Ingersoll-Rand, New York, N. Y.
McGowan Co., John H., Cincinnati, O.
National Steam Pump Co., Upper Sandusky, O.
Rumsey Pump Corp., Seneca Falls, N. Y.
Uniflow Mfg. Co., Erie, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, ROTARY

American Hard Rubber Co., New York, N. Y. (Hard Rubber)
Anderson Rotary Pump Co., New York, N. Y.
Beach-Russ Co., New York, N. Y.
Blackmer Pump Co., Grand Rapids, Mich.
Davidson Co., M. T., New York, N. Y.
Decatur Pump Co., Decatur, Ill.
Le Laval Steam Turbine Co., Trenton, N. J.
●Deming Co., Salem, O.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Gardner-Denver Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Johnson Co., S. T., Oakland, Cal.
Johnston & Jennings Co., Cleveland, O.
Kinney Mfg. Co., Boston, Mass.
Logan Engineering Co., Chicago, Ill. (Radial diaphragm)
Martocello & Co., Jos. A., Philadelphia, Pa.
McGowan Co., John H., Cincinnati, O.
●Monarch Mfg. Wks., Inc., Philadelphia, Pa.
●Nash Engineering Co., South Norwalk, Conn.
Oberdorfer Brass Co., M. L., Syracuse, N. Y.
Quimby Pump Co., Inc., Newark, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Corp., Seneca Falls, N. Y.
Taber Pump Co., Buffalo, N. Y.
Trimount Rotary Power Co., East Dedham, Mass.
Tuthill Pump Co., Chicago, Ill.
Viking Pump Co., Cedar Falls, Ia.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, STEAM

●American Steam Pump Co., Battle Creek, Mich.
Austin-Mason Co., New York, N. Y.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Columbus Steam Pump Wks., Co., Columbus, O.
Davidson Co., M. T., New York, N. Y.
Domestic Engine & Pump Co., New York, N. Y.
●Fairbanks, Morse & Co., Chicago, Ill.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Gardner-Denver Co., Quincy, Ill.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Ingersoll-Rrand, New York, N. Y.
McGowan Co., John H., Cincinnati, O.
National Steam Pump Co., Upper Sandusky, O.
Union Steam Pump Co., Battle Creek, Mich.
Warren Steam Pump Co., Inc., Warren, Mass.
Weinman Pump Co., Columbus, O.
●Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, SUMP

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
American Well Wks., Aurora, Ill.
Austin-Mason Co., New York, N. Y.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Chicago Pneumatic Tool Co., New York, N. Y.
Chicago Pump Co., Chicago, Ill.
Columbus Steam Pump Wks., Co., Columbus, O.
Davidson Co., M. T., New York, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
●Deming Co., Salem, O.
Domestic Engine & Pump Co., New York, N. Y.
Economy Pumping Machinery Co., Inc., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Goulds Pumps, Inc., Seneca, Falls, N. Y.
Guild & Garrison, Inc., Brooklyn, N. Y.
Imperial Brass Mfg. Co., Chicago, Ill.
●Ingersoll-Rand, New York, N. Y.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
McGowan Co., John H., Cincinnati, O.
Micro-Westco, Inc., Bettendorf, Ia.
Morris Machine Wks., Baldwinsville, N. Y.
●Nash Engineering Co., South Norwalk, Conn.
Oberdorfer Brass Co., M. L., Syracuse, N. Y.
Penberthy Injector Co., Detroit, Mich.
●Pomona Pump Co., Pomona, Cal.
Quimby Pump Co., Inc., Newark, N. J.
Rumsey Pump Corp., Seneca Falls, N. Y.
Swaby Mfg. Co., Chicago, Ill.
Taber Pump Co., Buffalo, N. Y.
Uniflow Mfg. Co., Erie, Pa.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
Weil Pump Co., Chicago, Ill.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, VACUUM

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●American Steam Pump Co., Battle Creek, Mich.
Beach-Russ Co., New York, N. Y.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Chicago Pneumatic Tool Co., New York, N. Y.
Chicago Pump Co., Chicago, Ill.
Columbus Steam Pump Wks. Co., Columbus, O.
Croll-Reynolds Engineering Co., Inc., New York, N. Y.
Davidson Co., M. T., New York, N. Y.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill.
Domestic Engine & Pump Co., New York, N. Y.
●Dunham Co., C. A., Chicago, Ill.
Economy Pumping Machinery Co., Chicago, Ill.
Elliott Co., Jeannette, Pa.
Foster Pump Wks., Inc., Brooklyn, N. Y.
Foster Wheeler Corp., New York, N. Y.
Fuller Co., Catasauqua, Pa.
Gardner-Denver Co., Quincy, Ill.
Guild & Garrison, Inc., Brooklyn, N. Y.
●Hoffman Specialty Co., Waterbury, Conn.
●Ingersoll-Rand, New York, N. Y.
Johnson Corp., Three Rivers, Mich.
Kinney Mfg. Co., Boston, Mass.
Leiman Bros., Inc., Newark, N. J.
McGowan Co., John H., Cincinnati, O.
●Nash Engineering Co., South Norwalk, Conn.
National Steam Pump Co., Upper Sandusky, O.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Reed Steam Equipment Co., Bridgeport, Conn.
Roots-Connersville Blower Corp., Connersville, Ind.
Schutte & Koerting Co., Philadelphia, Pa.
Skidmore Corp., St. Joseph, Mich.
Sterling Engineering Co., Milwaukee, Wis.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, VISCOUS LIQUIDS AND HEAVY MATERIALS

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Austin-Mason Co., New York, N. Y.
Beach-Russ Co., New York, N. Y.
●Buffalo Pumps, Inc., Buffalo, N. Y.
Chain Belt Co., Milwaukee, Wis.
Chicago Pump Co., Chicago, Ill.
Columbus Steam Pump Wks. Co., Columbus, O.
Davidson Co., M. T., New York, N. Y.

Economy Pumping Machinery Co., Inc., Chicago, Ill.
•Fairbanks, Morse & Co., Chicago, Ill.
Gardner-Denver Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
•Ingersoll-Rand, New York, N. Y.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Morris Machine Wks., Baldwinsville, N. Y.
Quimby Pump Co., Inc., Newark, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Corp., Seneca Falls, N. Y.
Taber Pump Co., Buffalo, N. Y.
Victor Equipment Co., Kimball-Krogh Pump Div., Los Angeles, Cal.
Viking Pump Co., Cedar Falls, Ia.
•Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., Chicago, Ill.

PUNCHES, SHEET METAL

Bertsch & Co., Inc., Cambridge City, Ind.
•Buffalo Forge Co., Buffalo, N. Y.
Hendley & Wittemore Co., Beloit, Wis.
Kidder Mfg. Co., Inc., J. F., Burlington, Vt.
Niagara Machine & Tool Wks., Buffalo, N. Y.
Parker-Kalon Corp., New York, N. Y.
Peck, Stow & Wilcox Co., Southington, Conn.
Pels & Co., Inc., Henry, New York, N. Y.
Whitney Mfg. Co., W. A., Rockford, Ill.
Whitney Metal Tool Co., Rockford, Ill.
Wiedemann Machine Co., Philadelphia, Pa.
Zeh & Hanemann Co., Newark, N. J.

QUADRANTS, DAMPER

Hart & Cooley Mfg. Co., Chicago, Ill.
Northern Weatherstrip Co., Duluth, Minn.
Ohio Products Co., Cleveland, O.
Parker-Kalon Corp., New York, N. Y.
United States Register Co., Battle Creek, Mich.
•Young Regulator Co., Cleveland, O.

RADIATION, CONVECTION TYPE, CAST IRON

•American Radiator Co., New York, N. Y.
•Crane Co., Chicago, Ill.
National Radiator Corp., Johnstown, Pa.
Richmond Radiator Co., Inc., Uniontown, Pa.
Smith Co., H. B., Westfield, Mass.
•Unit Heater & Cooler Co., Wausau, Wis.
United States Radiator Corp., Detroit, Mich.
Utica Radiator Corp., Utica, N. Y.
Weil-McLain Co., Chicago, Ill.

RADIATION, CONVECTION TYPE, NON-FERROUS

•American Radiator Co., New York, N. Y.
Bush Mfg. Co., Hartford, Conn.
Commodore Heaters Corp., New York, N. Y.
•Dunham Co., C. A., Chicago, Ill.
•Grinnell Co., Inc., Providence, R. I.
Hexcel Radiator Co., Racine, Wis.
McCord Radiator & Mfg. Co., Detroit, Mich.
•McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
Perfex Radiator Co., Milwaukee, Wis.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Rome-Turney Radiator Co., Rome, N. Y.
Super Radiator Corp., Minneapolis, Minn.
•Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
Vulcan Radiator Co., Hartford, Conn.
•Webster & Co., Warren, Camden, N. J.
•Young Radiator Co., Racine, Wis.

RADIATION, DIRECT

•American Radiator Co., New York, N. Y.
•Burnham Boiler Corp., Irvington, N. Y.
Clow, Jas. B. & Sons, Chicago, Ill. (Gas fired)
•Crane Co., Chicago, Ill.
Fowler & Wolfe Radiator Co., Norristown, Pa.
Hart & Crouse Co., Inc., Utica, N. Y.
International Heater Co., Utica, N. Y.
Logansport Radiator Equipment Co., Logansport, Ind.
National Radiator Corp., Johnstown, Pa.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Prox Co., Frank, Terre Haute, Ind.
Richmond Radiator Co., Inc., Uniontown, Pa.
Shaw-Perkins Mfg. Co., Pittsburgh, Pa.
Slater Mfg. Co., Wakefield, Mass. (Baseboard)
Smith Co., H. B., Westfield, Mass.
Thatcher Co., Newark, N. J.
United States Radiator Corp., Detroit, Mich.
Utica Radiator Corp., Utica, N. Y.
Weil-McLain Co., Chicago, Ill.

RADIATOR HANGERS

See Hangers or Brackets, Radiator

RADIATOR VALVES

See Valves, Radiator

REAMERS, PIPE

American Pipe Tool Co., Chicago, Ill.
Armstrong Bros. Tool Co., Chicago, Ill.
Armstrong Mfg. Co., Bridgeport, Conn.
Beaver Pipe Tools, Inc., Warren, O.
Nye Tool & Machine Wks., Chicago, Ill.
Toledo Pipe Threading Machine Co., Toledo, O.
•Walworth Co., New York, N. Y.

RECIPROCATING PUMPS

See Pumps, Reciprocating

RECORDER-CONTROLLERS, COMBINED TEMPERATURE AND HUMIDITY

•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
•Taylor Instrument Companies, Rochester, N. Y.

RECORDER-CONTROLLERS, HUMIDITY

•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
•Johnson Service Co., Milwaukee, Wis.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
•Taylor Instrument Companies, Rochester, N. Y.

RECORDER-CONTROLLERS, TEMPERATURE

Bailey Meter Co., Cleveland, O.
•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
•Johnson Service Co., Milwaukee, Wis.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
•Powers Regulator Co., Chicago, Ill.
•Taylor Instrument Companies, Rochester, N. Y.

RECORDERS, COMBINED TEMPERATURE AND HUMIDITY

•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
•Friez & Sons, Inc., Julien P., Baltimore, Md.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
•Taylor Instrument Companies, Rochester, N. Y.
Thwing-Albert Instrument Co., Philadelphia, Pa.
Trerice Co., H. O., Detroit, Mich.

RECORDERS, COMBUSTION

Bailey Meter Co., Cleveland, O.
•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis, Mo.
Foxboro Co., Foxboro, Mass.
Hays Corp., Michigan City, Ind.
Leeds & Northrup Co., Philadelphia, Pa.
Republic Flow Meters Co., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Uehling Instrument Co., Paterson, N. J.

RECORDERS, DRAFT

Bailey Meter Co., Cleveland, O.
•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis, Mo.
Foxboro Co., Foxboro, Mass.
Hays Corp., Michigan City, Ind.
Mason-Neilan Regulator Co., Boston, Mass.
Republic Flow Meters Co., Chicago, Ill.
Uehling Instrument Co., Paterson, N. J.

RECORDERS, HUMIDITY

•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
•Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
•Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

RECORDERS, LIQUID LEVEL

Bailey Meter Co., Cleveland, O.
•Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
•Friez & Sons, Inc., Julien P., Baltimore, Md.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.

Morey & Jones, Ltd., Los Angeles, Calif.
Republic Flow Meters Co., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

RECORDERS, PRESSURE

Ashton Valve Co., Cambridge, Mass.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Defender Automatic Regulator Co., St. Louis, Mo.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Star Brass Mfg. Co., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
Uehling Instrument Co., Paterson, N. J.
United States Gauge Co., New York, N. Y.

RECORDERS, TEMPERATURE

Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
●Powers Regulator Co., Chicago, Ill.
●Practical Instrument Co., Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Thwing-Albert Instrument Co., Philadelphia, Pa.
Trerice Co., H. O., Detroit, Mich.

RECORDERS, VACUUM

Ashton Valve Co., Cambridge, Mass.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Star Brass Mfg. Co., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
Uehling Instrument Co., Paterson, N. J.
United States Gauge Co., New York, N. Y.

RECORDING THERMOMETERS

See Thermometers, Recording

REDUCERS, SPEED

Ajax Flexible Coupling Co., Westfield, N. Y. (Fractional sizes —⅛ to 1 hp)
●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Boston Gear Wks., Inc., North Quincy, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Diehl Mfg. Co., Elizabethport, N. J. (Helical, worm)
General Electric Co., Schenectady, N. Y.
Janette Mfg. Co., Chicago, Ill. (Motorized)
Jones Foundry Machine Co., W. A., Chicago, Ill.
Link-Belt Co., Chicago, Ill.
Medart Co., St. Louis, Mo.
Morse Chain Co., Ithaca, N. Y. (Chain speed)
New Departure Div., General Motors Corp., Bristol, Conn.
Philadelphia Gear Co., Philadelphia, Pa.
Star Electric Motor Co., Bloomfield, N. J.
Poole Foundry & Machine Co. Baltimore Md.
Smith, Inc., Winfield H., Springville, N. Y.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

REFRIGERANTS

Ansul Chemical Co., Marinette, Wis. (methyl chloride, sulphur dioxide)
Armour Ammonia Wks., Chicago, Ill. (ammonia)
Carbide & Carbon Chemicals Corp., New York, N. Y.
du Pont de Nemours & Co., E. I., R. & H. Chemicals Dept., Niagara Falls, N. Y. (methyl chloride)
Kinetic Chemicals, Inc., Wilmington, Del. ("Freon")
Liquid Carbonic Corp., Chicago, Ill. (carbon dioxide)
Pure Carbonic, Inc., New York, N. Y. (carbon dioxide)
Virginia Smelting Co., West Norfolk, Va. (methyl chloride)

REFRIGERATING COMPRESSORS

See Compressors, Refrigerating

REFRIGERATING VALVES

See Valves, Refrigerating

REFRIGERATION CONTROLS

See Valves, Refrigeration

REFRIGERATION FITTINGS

See Fittings, Refrigeration

REGISTERS

●Auer Register Co., Cleveland, O.
●Barber-Colman Co., Rockford, Ill.
Best Register Co., Milwaukee, Wis.
Diamond Mfg. Co., Wyoming, Pa.
Duckworth-Elsey Metal Products Co., Detroit, Mich.
Hart & Cooley Mfg. Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.
●Independent Register Co., Cleveland, O.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Knowles Mushroom Ventilator Co., New York, N. Y.
Mueller Furnace Co., L. J., Milwaukee, Wis.
Register & Grille Mfg. Co., Brooklyn, N. Y.
Rock Island Register Co., Rock Island, Ill.
●Tuttle & Bailey, Inc., New Britain, Conn.
United States Register Co. Battle Creek, Mich.
●Waterloo Register Co., Waterloo, Ia.

REGULATORS, AIR VELOCITY

●Johnson Service Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.

REGULATORS, DRAFT

●American Radiator Co., New York, N. Y.
●Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Bailey Meter Co., Cleveland, O.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Burrows Mfg. Co., F. A., York, Pa.
Carrick Engineering Co., Michigan City, Ind.
Cash Co., A. W., Decatur, Ill.
Crew-Taylor Engineering Corp., New York, N. Y.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
Engineer Co., New York, N. Y.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Hagan Corp., Pittsburgh, Pa.
Hotstream Heater Co., Cleveland, O.
Illinois Engineering Co., Chicago, Ill.
International Draft Control Co., Cleveland, O.
Kieley & Mueller, Inc., New York, N. Y.
Leeds & Northrup Co., Philadelphia, Pa.
Locke Regulator Co., Salem, Mass.
Mason-Neilan Regulator Co., Boston, Mass.
Master Electric Co., Dayton, O.
Mercoid Corp., Chicago, Ill.
Perfex Controls Co., Milwaukee, Wis.
Pioneer Heat Regulator Corp., Dayton, O.
Republic Flow Meters Co., Chicago, Ill. (Industrial)
Ruggles-Klingemann Mfg. Co., Salem, Mass.
●Sarco Co., Inc., New York, N. Y.
Shallcross Controls, Inc., Milwaukee, Wis.
Sheer Co., H. M., Quincy, Ill.
Spence Engineering Co., Inc., Walden, N. Y.
United Electric Controls Co., Boston, Mass.
●Webster & Co., Warren, Camden, N. J.

REGULATORS, PRESSURE, GAS

Barber Gas Burner Co., Cleveland, O.
Belfield Co., H., Philadelphia, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
Bryant Heater Co., Cleveland, O.
Brown Instrument Co., Div. of Minneapolis-Regulator Co., Philadelphia, Pa.
Burdett Mfg. Co., Chicago, Ill.
Cooper Co., Clark, Philadelphia, Pa.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Davis Regulator Co., Chicago, Ill.
d'Este Co., Julian, Charlestown, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Fulton Sylphon Co., Knoxville, Tenn.
●General Controls Co., San Francisco, Cal.
Harris Calorific Co., Cleveland, O.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Mason-Neilan Regulator Co., Boston, Mass.

McAlear Mfg. Co., Chicago, Ill.
●Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Milburn Co., Alexander, Baltimore, Md.
Monitor Controller Co., Baltimore, Md.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Payne Furnace & Supply Co., Beverly Hills, Cal. (Low)
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Republic Flow Meters Co., Chicago, Ill. (Industrial)
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Shallcross Controls, Inc., Milwaukee, Wis.
Sheer Co., H. M., Quincy, Ill.
Spence Engineering Co., Inc., Walden, N. Y.
Spencer Thermostat Co., Attleboro, Mass.
Square D Co., Detroit, Mich.
Strong, Carlisle & Hammond Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, PRESSURE, HOT WATER HEATING SYSTEMS

Beaton & Cadwell Mfg. Co., New Britain, Conn.
Belfield Co., H., Philadelphia, Pa.
Bordo Co., Inc., L. J., Glenside, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Cooper Co., Clark, Philadelphia, Pa.
d'Este Co., Julian, Charlestown, Mass.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Fulton Sylphon Co., Knoxville, Tenn.
Kainer Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Leslie Co., Lyndhurst, N. J.
Maid-O-Mist, Inc., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mueller Co., Decatur, Ill.
Penberthy Injector Co., Detroit, Mich.
Republic Flow Meters Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Stevens-Root Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Triplex Mfg. Co., Peru, Ind.
Tryco Products, Inc., Westfield, Mass.
Watts Regulator Co., Lawrence, Mass.

REGULATORS, PRESSURE, LIQUID

Atlas Valve Co., Inc., Newark, N. J.
Belfield Co., H., Philadelphia, Pa.
Boylston Steam Specialty Co., Chicago,, Ill.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Cash Co., A. W., Decatur, Ill.
Central Brass Mfg. Co., Cleveland, O.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Cooper Co., Clark, Philadelphia.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Fulton Sylphon Co., Knoxville, Tenn.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Locke Regulator Co., Salem, Mass.
Marsh Corp., Jas. P., Chicago, Ill.
Nason-Neilan Regulator Co., Boston, Mass.
Mercoid Corp., Chicago, Ill.
●Monarch Mfg. Wks., Inc., Philadelphia, Pa.
Monitor Controller Co., Baltimore, Md.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Schaphorst, W. F., Newark, N. J.
Schutte & Koerting Co., Philadelphia, Pa.
Shallcross Controls, Inc., Milwaukee, Wis.
Spence Engineering Co., Inc., Walden, N. Y.
Square D Co., Detroit, Mich.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Stickle Steam Specialties Co., Indianapolis, Ind.
Strong, Carlise & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
Tryco Products, Inc., Westfield, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Watts Regulator Co., Lawrence, Mass.

REGULATORS, PRESSURE, STEAM

●American District Steam Co., North Tonawanda, N. Y.
●American Radiator Co., New York, N. Y.
Bailey Meter Co., Cleveland, O.
Belfield Co., H., Philadelphia, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Burrows Mfg. Co., F. A., York, Pa.
Cash Co., A. W., Decatur, Ill.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Cooper Co., Clark, Philadelphia.
●Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
●Dunham Co., C. A., Chicago, Ill.
Eclipse Fuel Engineering Co., Rockford, Ill.
Engineer Co., New York, N. Y.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Fulton Sylphon Co., Knoxville, Tenn.
Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.
Gorton Heating Corp., Cranford, N. J.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Keckley Co., O. C., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Klipfel Mfg. Co., Chicago, Ill.
Leslie Co., Lyndhurst, N. J.
Locke Regulator Co., Salem, Mass.
Marsh Corp., Jas. P., Chicago, Ill.
Nason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
Monitor Controller Co., Baltimore, Md.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
Schade Valve Mfg. Co., Philadelphia, Pa.
Shallcross Controls, Inc., Milwaukee, Wis.
Spence Engineering Co., Inc., Walden, N. Y.
Squires Co., C. E., Cleveland, O.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Stickle Steam Specialties Co., Indianapolis, Ind.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
United Electric Controls Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Watts Regulator Co., Lawrence, Mass.
●Webster & Co., Warren, Camden, N. J.
Williams Gauge Co., Pittsburgh, Pa.

REGULATORS, STATIC PRESSURE

Eclipse Fuel Engineering Co., Rockford, Ill.
Foster Engineering Co., Newark, N. J.
●Johnson Service Co., Milwaukee, Wis.
Mason-Neilan Regulator Co., Boston, Mass.
●Powers Regulator Co., Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.

REGULATORS, TEMPERATURE

●American Radiator Co., New York, N. Y.
●Automatic Products Co., Milwaukee, Wis.
●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Burling Instrument Co., Newark, N. J.
Consolidated Ashcroft Hancock Co., Bridgeport, Conn.
Cook Electric Co., Chicago, Ill.
Cooper Co., Clark, Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
●General Controls Co., San Francisco, Cal.
H-B Instrument Co., Philadelphia, Pa.
Illinois Engineering Co., Chicago, Ill.
●Johnson Service Co., Milwaukee, Wis.
Keckley Co., O. C., Chicago, Ill.
Lawler Automatic Controls, Inc., Mount Vernon, N. Y.
Leeds & Northrup Co., Philadelphia, Pa.
Leonard Rooke Co., Providence, R. I.
Leslie Co., Lyndhurst, N. J.
Locke Regulator Co., Salem, Mass.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Mercoid Corp., Chicago, Ill.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.

Ruggles-Klingemann Mfg. Co., Salem, Mass.
Russell Electric Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Spence Engineering Co., Inc., Walden, N. Y.
Spencer Thermostat Co, Attleboro, Mass.
Square D Co., Detroit, Mich.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Watson & McDaniel Co., Philadelphia, Pa.
White Mfg. Co., St. Paul, Minn.

RELAYS, ELECTRICAL

●Allen-Bradley Co., Milwaukee, Wis.
●Automatic Products Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
Bender Warrick Corp., Birmingham, Mich.
●Clark Controller Co., Cleveland, O.
Cutler-Hammer, Inc., Milwaukee, Wis.
Dunn, Inc., Struthers, Philadelphia, Pa.
Durakool, Inc., Elkhart, Ind.
Electric Controller & Mfg. Co., Cleveland, O.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●General Controls Co., San Francisco, Cal.
General Electric Co., Schenectady, N. Y.
H-B Instrument Co., Philadelphia, Pa.
Hart Mfg. Co., Hartford, Conn.
McCorkle Co., D. H., Berkeley, Calif.
Mercoid Corp., Chicago, Ill.
Monitor Controller Co., Baltimore, Md.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
Russell Electric Co., Chicago, Ills.
Tork Clock Co., Inc., Mount Vernon, N. Y.
Ward Leonard Electric Co., Mt. Vernon, N. Y.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., Newark, N. J.
White Mfg. Co., St. Paul, Minn.

RELIEF VALVES

See Valves, Relief

REPAIR CLAMPS, PIPE

See Clamps, Pipe Repair

REVOLVING DOORS

See Doors, Revolving

ROD, WELDING

Air Reduction Sales Co., New York, N. Y.
●American Brass Co., Waterbury, Conn.
American Chain Co., Inc., Bridgeport, Conn.
American Steel & Wire Co., Chicago, Ill.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Crucible Steel Co. of America, New York, N. Y.
Duraloy Co., Pittsburgh, Pa. (Stainless)
Imperial Brass Mfg. Co., Chicago, Ill.
Keasbey & Mattison Co., Ambler, Pa.
Laclede Steel Co., St. Louis, Mo.
●Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.
Maurath, Inc., Cleveland, O.
Milburn Co., Alexander, Baltimore, Md.
Page Steel & Wire Division of American Chain Co., Inc., Monessen, Pa.
●Republic Steel Corp., Cleveland, O.
●Revere Copper & Brass, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Seneca Wire & Mfg. Co., Fostoria, O.
Sight Feed Generator Co., Richmond, Ind.
Una Welding, Inc., E. Cleveland, O.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Youngstown Sheet & Tube Co., Youngstown, O.

ROLLER BEARINGS

See Bearings, Roller

ROOF VENTILATORS

See Ventilators, Roof

ROOM HUMIDIFIERS

See Humidifiers, Unit, Room Type and Unit Air Humidifiers

ROOM THERMOSTATS

See Thermostats, Room or Wall

ROTARY PUMPS

See Pumps, Rotary

RUBBER BELTING

See Belting, Rubber

RUBBER PACKING

See Packing, Rubber

RUBBER PIPE

See Pipe, Hard Rubber

SEAMLESS PIPE

See Pipe, Seamless, Steel

SEPARATORS, AIR

Adams Co., R. P., Buffalo, N. Y.
Bubar, Hudson H., New York, N. Y.
Centrifix Corp., Cleveland, O.
●Crane Co., Chicago, Ill.
Direct Separator Co., Inc., Syracuse, N. Y.
Illinois Engineering Co., Chicago, Ill.
Johnson Corp., Three Rivers, Mich.
Kellogg Compressor & Mfg. Corp., Rochester, N. Y.
Leavitt Machine Co., Orange, Mass.
McAlear Mfg. Co., Chicago, Ills.
Milburn Co., Alexander, Baltimore, Md.
Spray Engineering Co., Somerville, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Wright-Austin Co., Detroit, Mich.

SEPARATORS, STEAM AND OIL

Acme Industries, Inc., Jackson, Mich.
Adams Co., R. P., Buffalo, N. Y.
●Air-Maze Corp., Cleveland, O. (For diesel engines)
●American District Steam Co., North Tonawanda, N. Y.
Andrews Bradshaw Co., Blawnox, Pa.
Barrett Machine Co., N. S. Pittsburgh, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
Centrifix Corp., Cleveland, O.
Cochrane Corp., Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Croll-Reynolds Engineering Co., Inc., New York, N. Y.
Direct Separator Co., Inc., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.
Fisher Governor Co., Marshalltown, Ia.
Illinois Engineering Co., Chicago, Ill.
Johnson Corp., Three Rivers, Mich.
Kieley & Mueller, Inc., New York, N. Y.
Kisco Boiler & Engineering Co., St. Louis, Mo.
McAlear Mfg. Co., Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Stickle Steam Specialties Co., Indianapolis, Ind.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
●Webster & Co., Warren, Camden, N. J.
Wright-Austin Co., Detroit, Mich.

SEWAGE EJECTORS

See Ejectors, Sewage

SHEARS, HAND

Armstrong-Blum Mfg. Co., Chicago, Ill.
Bremil Mfg. Co., Erie, Pa.
Champion Blower & Forge Co., Lancaster, Pa.
Clauss Shear Co., Fremont, O.
Hendley & Whittemore, Beloit, Wis.
Marshalltown Mfg. Co., Marshalltown, Ia.
Niagara Machine & Tool Wks., Buffalo, N. Y.
Peck, Stow & Wilcox Co., Southington, Conn.
Pels & Co., Inc., Henry, New York, N. Y.
Stanley Wks., New Britain, Conn.
Viking Shear Co., Erie, Pa.
Whitney Mfg. Co., W. A., Rockford, Ill.
Whitney Metal Tool Co., Rockford, Ill.
Wiss & Sons Co., J., Newark, N. J.

SHEARS, POWER

Allsteel Press Co., Inc., Chicago, Ill.
American Foundry Equipment Co., Mishawaka, Ind.
Bertsch & Co., Inc., Cambridge City, Ind.
●Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Shaper Co., Cincinnati, O.
Dreis & Krump Mfg. Co., Chicago, Ill.
Heartley Machine & Tool Co., Toledo, O.
Hendley & Whittemore, Beloit, Wis.
Marshalltown Mfg. Co., Marshalltown, Ia.
New Albany Machine Mfg. Co., New Albany, Ind.
Niagara Machine & Tool Wks., Buffalo, N. Y.
Peck, Stow & Wilcox Co., Southington, Conn.
Pels & Co., Inc., Henry, New York, N. Y.
Stanley Wks., New Britain, Conn.
●Torrington Mfg. Co., Torrington, Conn.
Viking Pump Co., Cedar Falls, Ia.

SHEET METAL BRAKES

See Brakes, Sheet Metal

SHEET METAL DUCTS

See Ducts and Duct Fittings, Prefabricated

SHEET METAL FITTINGS

See Ducts and Duct Fittings, Prefabricated

SHEET METAL PUNCHES

See Punches, Sheet Metal

SHEETS, ALLOY

Allegheny Steel Co., Brackenridge, Pa.
●American Brass Co., Waterbury, Conn.
●American Rolling Mill Co., Middletown, O.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
Crucible Steel Co. of America, New York, N. Y.
Duraloy Co., Pittsburgh, Pa.
Duriron Co., Inc., Dayton, O.
Ingersoll Steel & Disc Co., Chicago, Ill.
International Nickel Co., New York, N. Y.
Ludlum Steel Co., Watervliet, N. Y.

●Republic Steel Corp., Cleveland, O.
●Revere Copper & Brass, Inc., New York, N. Y.
Sharon Steel Corp., Sharon, Pa.

SHEETS, ALUMINUM

Aluminum Co. of America, Pittsburgh, Pa.
Fairmont Aluminum Co., Fairmont, W. Va.

SHEETS, COPPER

●American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Hussey & Co., C. G., Pittsburgh, Pa.
New Haven Copper Co., Seymour, Conn.
●Revere Copper & Brass, Inc., New York, N. Y.
United States Brass & Copper Co., Hyde Park, Boston, Mass.

SHEETS, COPPER BEARING STEEL

●American Rolling Mill Co., Middletown, O.
Apollo Steel Co., Apollo, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Follansbee Bros. Co., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Gulf States Steel Co., Birmingham, Ala.
Inland Steel Co., Chicago, Ill.
Lukens Steel Co., Coatesville, Pa.
National Steel Corp., Pittsburgh, Pa.
Newport Rolling Mill Co., Newport, Ky.
Otis Steel Co., Cleveland, O.
●Republic Steel Corp., Cleveland, O.
Sharon Steel Corp., Sharon, Pa.
Superior Sheet Steel Co., Canton, O.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
Weirton Steel Co., Weirton, W. Va.
●Wheeling Steel Corp., Wheeling, W. Va.
●Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, IRON AND STEEL, GALVANIZED

●American Rolling Mill Co., Middletown, O.
Apollo Steel Co., Apollo, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Byers Co., A. M., Pittsburgh, Pa. (Wrought iron)
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, New York, N. Y.
Follansbee Bros. Co., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Gulf States Steel Co., Birmingham, Ala.
Inland Steel Co., Chicago, Ill.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Lukens Steel Co., Coatesville, Pa.
Lyon, Conklin & Co., Inc., Baltimore, Md.
National Steel Corp., Pittsburgh, Pa.
Newport Rolling Mill Co., Newport, Ky.
Niles Rolling Mill Co., Niles, O.
●Republic Steel Corp., Cleveland, O.
Sharon Steel Corp., Sharon, Pa.
Superior Sheet Steel Co., Canton, O.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
Weirton Steel Co., Weirton, W. Va.
●Wheeling Steel Corp., Wheeling, W. Va.
●Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, LEAD

Andrews Lead Co., Long Island City, N. Y.
Belmont Smelting & Refining Wks., Inc., Brooklyn, N. Y.
Eagle-Picher Lead Co., Cincinnati, O.
Flemm Lead Co., Inc., Long Island City, N. Y.
Lissberger & Son, Inc., Marks, Long Island City, N. Y.
National Lead Co., New York, N. Y.
Rochester Lead Wks., Rochester, N. Y.

SHEETS, TIN

Belmont Smelting & Refining Wks., Inc., Brooklyn, N. Y.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Follansbee Bros. Co., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Inland Steel Co., Chicago, Ill.
Weirton Steel Co., Weirton, W. Va.
●Wheeling Steel Corp., Wheeling, W. Va.
●Youngstown Sheet & Tube Co., Youngstown, O.

SHEETS, ZINC

American Nickeloid Co., Peru, Ill.
American Zinc Products Co., Greencastle, Ind.
Belmont Smelting & Refining Wks., Inc., Brooklyn, N. Y.
Hegeler Zinc Co., Danville, Ill.
Illinois Zinc Co., Chicago, Ill.
Matthiessen & Hegeler Zinc Co., La Salle, Ill.
New Jersey Zinc Sales Co., New York, N. Y.

SOLDER, BRAZING ALLOYS, AND FLUXES

Air Reduction Sales Co., New York, N. Y.
●American Brass Co., Waterbury, Conn.
American Solder & Flux Co., Philadelphia, Pa.
Belmont Smelting & Refining Wks., Inc., Brooklyn, N. Y.
Benson Co., Inc., Alex R., Hudson, N. Y.
Burnley Battery & Mfg. Co., Northeast, Pa.
Eagle-Picher Lead Co., Cincinnati, O.
Gardiner Metal Co., Chicago, Ill.
Handy & Harman, New York, N. Y. (Silver)
Imperial Brass Mfg. Co., Chicago, Ill.
Kester Solder Co., Chicago, Ill.
●Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.
Lissberger & Son, Inc., Marks, Long Island City, N. Y.
National Lead Co., New York, N. Y.
Ruby Chemical Co., Columbus, O.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SOLENOID VALVES

See Valves, Solenoid

SOUND DEADENING, CEILING AND WALL

See Insulation, Sound Deadening, Ceiling and Wall

SOUND DEADENING FOR DUCTS

See Insulation, Sound Deadening, Duct

SOUND INDICATORS

See Indicators, Sound Level

SPEED REDUCERS

See Reducers, Speed

SPIRAL PIPE

See Pipe, Spiral, Riveted and Welded

SPOT WELDERS

See Welders, Spot

SPRAY HUMIDIFIERS

See Humidifiers, Direct, Spray Head

SPRAY NOZZLES

See Nozzles, Spray

SPRINKLER HEADS

See Heads, Sprinkler

STAINLESS SHEETS

See Sheets, Alloy

STANDS, VISE

American Pipe Tool Co., Chicago, Ill.
Armstrong Mfg. Co., Bridgeport, Conn.
Hollands Mfg. Co., Erie, Pa.
Martin & Sons, H. P., Owensboro, Ky.
Nye Tool & Machine Wks., Chicago, Ill.
●Ridge Tool Co., Elyria, O.
Western Wire Products Co., St. Louis, Mo.

STARTERS, MOTOR

See Controllers and Starters, Motor

STEAM EJECTORS

See Compressors, Refrigerating, Steam Jet

STEAM ENGINES

See Engines, Steam

STEAM JET REFRIGERATION

See Compressors, Refrigerating, Steam Jet

STEAM PRESSURE REGULATORS

See Regulators, Pressure, Steam

STEAM PUMPS

See Pumps, Steam

STEAM SEPARATORS

See Separators, Steam and Oil

STEAM TRAPS

See Traps, Steam

STEEL PIPE

See Pipe, Steel

STEEL TUBING

See Tubing, Steel

STEEL UNIONS

See Unions, Steel

STEEL VALVES

See Valves, Gate and Valves, Globe

STOCKS AND DIES

American Pipe Tool Co., Chicago, Ill.
Armstrong Bros. Tool Co., Chicago, Ill.
Armstrong Mfg. Co., Bridgeport, Conn.
Beaver Pipe Tools, Inc., Warren, O.
Champion Blower & Forge Co., Lancaster, Pa.
Erie Tool Wks., Erie, Pa.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hollands Mfg. Co., Erie, Pa.
Jarecki Mfg. Co., Erie, Pa.
Nye Tool & Machine Wks., Chicago, Ill.
●Oster Mfg. Co., Cleveland, O.
●Ridge Tool Co., Elyria, O.
Toledo Pipe Threading Machine Co., Toledo, O.
●Walworth Co., New York, N. Y.

STOKERS, INDUSTRIAL AND COMMERCIAL

American Coal Burner Co., Chicago, Ill.
Anchor Stove & Range Co., New Albany, Ind.
Automatic Stoker Corp., Milwaukee, Wis.
Babcock & Wilcox Co., New York, N. Y.
Bluffton Mfg. Co., Findlay, O.
Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
Brownell Co., Dayton, O.
Burke Stoker & Mfg. Co., Chicago, Ill.
Burnham Stoker Co., Vancouver, Wash.
Butler Mfg. Co., Kansas City, Mo.
Canton Stoker Corp., Canton, O.
Christensen Machine Co., Salt Lake City, Utah.
Columbus Metal Products Co., Columbus, O.

Combustion Engineering Co., Inc., New York, N. Y.
Delta Stoker Co., Chicago, Ill.
●Detroit Stoker Co., Detroit, Mich.
Econocol Stoker Div. of Cotta Transmission Corp., Rockford, Ill.
Eddy Stoker Corp., Chicago, Ill.
●Fairbanks-Morse & Co., Chicago, Ill.
Firemood Machine Wks., Converse, Ind.
Flynn & Emrich Co., Baltimore, Md.
Frederick Iron & Steel Co., Frederick, Md.
Fuel Savers, Inc., Harrisburg, Pa.
Gehl Bros. Mfg. Co., West Bend, Wis.
Heating Assurance, Inc., Spokane, Wash.
Her-Born Engrg. & Mfg. Co., Sandusky, O.
Hoffman Combustion Engineering Co., Detroit, Mich.
Holcomb & Hoke Mfg. Co., Indianapolis, Ind.
Illinois Iron & Bolt Co., Chicago, Ill.
International Engineering Wks., Inc., Framingham, Mass.
Iron Fireman Mfg. Co., Cleveland, O.
Johnston & Jennings Co., Cleveland, O.
Jordan & Co., Paul R., Indianapolis, Ind.
Laclede Stoker Co., St. Louis, Mo.
Link-Belt Co., Chicago, Ill.
Mallory Sales Co., Dolton, Ill.
Marion Machine Foundry & Supply Co., Marion, Ind.
McClave-Brooks Co., Scranton, Pa.
Muncie Gear Wks., Inc., Muncie, Ind.
National Steam Pump Co., Upper Sandusky, O.
Neemes Foundry, Inc., Troy, N. Y.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
Paragon Kol-Master Corp., Oregon, Ill.
Patterson Foundry & Machine Co., East Liverpool, O.
Perfection Grate & Stoker Co., Springfield, Mass.
Redi Automatic Coal Burners, Inc., Spokane, Wash.
Riley Stoker Corp., Worcester, Mass.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Sampsel Stoker Corp., Mendota, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
Sinker-Davis Co., Indianapolis, Ind.
Spencer Heater Co., Williamsport, Pa.
Steel Products Engineering Co., Springfield, O.
Stokermatic Co., Salt Lake City, Utah.
Stokers, Inc., Detroit, Mich.
Taylor Engineering Co., Cincinnati, O.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Whiting Corp., Harvey, Ill.
Will-Burt Co., Orrville, O.

STONEWARE PIPE

See Pipe, Stoneware

STORAGE WATER HEATERS

See Heaters, Water, Storage

STRAINERS, PIPE LINE

●American District Steam Co., North Tonawanda, N. Y.
American Injector Co., Detroit, Mich.
Barrett, Haentjens & Co., Hazelton, Pa.
Blackmer Pump Co., Grand Rapids, Mich.
Buffalo Meter Co., Buffalo, N. Y.
Boylston Steam Specialty Co., Chicago, Ill.
Cash Co., A. W., Decatur, Ill.
Cashin Co., W. D., Boston, Mass.
Central Brass Mfg. Co., Cleveland, O.
●Crane Co., Chicago, Ill.
Cuno Engineering Corp., Meriden, Conn.
Davis Regulator Co., Chicago, Ill.
Direct Separator Co., Inc., Syracuse, N. Y.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Elliott Co., Jeannette, Pa.
Fisher Governor Co., Marshalltown, Ia.
●Grinnell Co., Providence, R. I.
Henry Valve Co., Chicago, Ill.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Kaye & MacDonald, Inc., West Orange, N. J.
Keckley Co., O. C., Chicago, Ill.
Kieley & Mueller, New York, N. Y.
Leslie Co., Lyndhurst, N. J.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., New York, N. Y.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
●Sarco Co., New York, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Spence Engineering Co., Walden, N. Y.
Spray Engineering Co., Somerville, Mass.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Sterling Engineering Co., Milwaukee, Wis.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
●Trane Co., La Crosse, Wis.
Tryco Products, Inc., Westfield, Mass.
Watts Regulator Co., Lawrence, Mass.
●Webster & Co., Warren, Camden, N. J.
Wright-Austin Co., Detroit, Mich.

STRIP HEATERS

See Heaters, Strip and Immersion, Electric

SUMP PUMPS

See Pumps, Sump

SURFACE, COOLING, BRINE

Acme Industries, Inc., Jackson, Mich.
Advanced Engineering Co., Philadelphia, Pa.
Advanced Refrigerating Systems Co., Philadelphia, Pa.
●Aerofin Corp., Newark, N. J.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Bush Mfg. Co., Hartford, Conn.
●Carbondale Machine Corp., Harrison, N. J.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.
●Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.
Marlo Coil Co., St. Louis, Mo.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
Niagara Blower Co., New York, N. Y.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
●Refrigeration Appliances, Inc., Chicago, Ill.
Reliance Refrigerating Machine Co., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Standard Galvanizing Co., Chicago, Ill.
●Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
●Unit Heater & Cooler Co., Wausau, Wis.
●Vilter Mfg. Co., Milwaukee, Wis.
●Wing Mfg. Co., L. J., New York, N. Y.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

SURFACE, COOLING, COLD WATER

Acme Industries, Inc., Jackson, Mich.
Adams Co., R. P., Buffalo, N. Y.
Advanced Engineering Co., Philadelphia, Pa.
Advanced Refrigerating Systems Co., Philadelphia, Pa.
●Aerofin Corp., Newark, N. J.
●American Radiator Co., New York, N. Y.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Bush Mfg. Co., Hartford, Conn.
●Carbondale Machine Corp., Harrison, N. J.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.
●Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.
General Electric Co., Schenectady, N. Y.
Heat Transfer Co., Huntington, Ind.
Hexcel Radiator Co., Racine, Wis.
Johnson Fan & Blower Corp., Chicago, Ill.
Larkin Refrigerating Corp., Atlanta, Ga.
Marlo Coil Co., St. Louis, Mo.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
Niagara Blower Co., New York, N. Y.
Perfex Radiator Co., Milwaukee, Wis.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
●Refrigeration Appliances, Inc., Chicago, Ill.
Reliance Refrigerating Machine Co., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
●Sturtevant Co., B. F., Boston, Mass.
Standard Galvanizing Co., Chicago, Ill.
Star Radiator Co., Los Angeles, Cal.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
●Unit Heater & Cooler Co., Wausau, Wis.
●Vilter Mfg. Co., Milwaukee, Wis.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Wing Mfg. Co., L. J., New York, N. Y.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

SURFACE, COOLING, DIRECT EXPANSION

Acme Industries, Inc., Jackson, Mich.
Adams Co., R. P., Buffalo, N. Y.
Advanced Engineering Co., Philadelphia, Pa.
Advanced Refrigerating Systems Co., Philadelphia, Pa.
●Aerofin Corp., Newark, N. J.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Bush Mfg. Co., Hartford, Conn.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
●Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.
General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
Hardy Mfg. Co., Inc., Dayton, O.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
●Kelvinator Corp., Detroit, Mich.
Larkin Refrigerating Corp., Atlanta, Ga.
Marlo Coil Co., St. Louis, Mo.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Marlo Coil Co., St. Louis, Mo.
Modine Mfg. Co., Racine, Wis.

●National Fan & Blower Corp., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Perfex Radiator Co., Milwaukee, Wis.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
●Refrigeration Appliances, Inc., Chicago, Ill.
Reliance Refrigerating Machine Co., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Standard Galvanizing Co., Chicago, Ill.
●Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
Triumph Ice Machine Co., Cincinnati, O.
●Unit Heater & Cooler Co., Wausau, Wis.
●Vilter Mfg. Co., Milwaukee, Wis.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

SURFACE, HEATING, FERROUS

●American Radiator Co., New York, N. Y.
Bayley Blower Co., Milwaukee, Wis.
●Burnham Boiler Co., Irvington, N. Y.
Shaw-Perkins Co., Pittsburgh, Pa.
●Unit Heater & Cooler Co., Wausau, Wis.
Wolff & Munier, Inc., New York, N. Y. (For panel heating)

SURFACE, HEATING, NON-FERROUS

●Aerofin Corp., Newark, N. J.
●American Radiator Co., New York, N. Y.
Bayley Blower Co., Milwaukee, Wis.
Bush Mfg. Co., Hartford, Conn.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
G. & O. Mfg. Co., New Haven, Conn.
General Electric Co., Schenectady, N. Y.
Hexcel Radiator Co., Racine, Wis.
Johnson Fan & Blower Corp., Chicago, Ill.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
Nelson Corp., Herman, Moline, Ill.
●Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Perfex Radiator Co., Milwaukee, Wis.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
●Refrigeration Appliances, Inc., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Russell Electric Co., Chicago, Ill.
Star Radiator Co., Los Angeles, Cal.
●Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
●Unit Heater & Cooler Co., Wausau, Wis.
Winchester Repeating Arms Co., New Haven, Conn.
●Wing Mfg. Co., L. J., New York, N. Y.
●Young Radiator Co., Racine, Wis.

SURFACE THERMOSTATS

See Thermostats, Surface

SWITCHES, ELECTRICAL

Adam Frank Electric Co., St. Louis, Mo.
●Allen-Bradley Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
●Clark Controller Co., Cleveland, O.
Cooper Co., Clark, Philadelphia, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
Delta-Star Electric Co., Chicago, Ill.
Dunn, Inc., Struthers, Philadelphia, Pa.
Durakool, Inc., Elkhart, Ind. (Mercury)
Electric Controller & Mfg. Co., Cleveland, O.
General Electric Co., Schenectady, N. Y.
Hart Mfg. Co., Hartford, Conn.
Jefferson Electric Co., Bellwood, Ill. (Mercury)
Marsh Corp., Jas. P., Chicago, Ill.
Mercoid Corp., Chicago, Ill. (Mercury)
Penn Electric Switch Co., Des Moines, Ia.
Square D Co., Detroit, Mich.
Tork Clock Co., Inc., Mount Vernon, N. Y.
Trumbull Electric Mfg. Co., Plainville, Conn.
Ward Leonard Electric Co., Mount Vernon, N. Y.
Webster Electric Co., Racine, Wis.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
White Mfg. Co., St. Paul, Minn.

SWITCHES, FLOAT, REFRIGERATION

●Alco Valve Co., Inc., St. Louis, Mo.
●Frick Co., Waynesboro, Pa.
Kisco Boiler & Engineering Co., St. Louis, Mo.
McDonell & Miller, Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.

SWITCHES, LIQUID LEVEL

●Allen-Bradley Co., Milwaukee, Wis.
Bender Warrick Corp., Birmingham, Mich.
Cissell Mfg. Co., W. M., Louisville, Ky.
●Clark Controller Co., Cleveland, O.
Cooper Co., Clark, Philadelphia, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
●Detroit Lubricator Co., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Hart Mfg. Co., Hartford, Conn.
McDonnell & Miller, Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Square D Co., Detroit, Mich.
Trumbull Electric Mfg. Co., Plainville, Conn.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, PRESSURE AND VACUUM

●Allen-Bradley Co., Milwaukee, Wis.
Boston Auto Gage Co., Pittsfield, Mass.
●Clark Controller Co., Cleveland, O.
Cooper Co., Clark, Philadelphia, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
●Detroit Lubricator Co., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Marsh Corp., Jas. P., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
Spencer Thermostat Co., Attleboro, Mass.
Square D Co., Detroit, Mich.
Trumbull Electric Mfg. Co., Plainville, Conn.
Uniflow Mfg. Co., Erie, Pa.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, TIME

●Detroit Luubricator Co., Detroit, Mich.
Electric Hot Heater Co., Tacoma, Wash.
●General Controls Co., San Francisco, Cal.
General Electric Co., Schenectady, N. Y.
Paragon Electric Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Rhodes, Inc., M. H., New York, N. Y.
Sangamo Electric Co., Springfield, Ill.
Tork Clock Co., Inc., Mount Vernon, N. Y.

SYSTEMS, HEATING, VACUUM

●American Radiator Co., New York, N. Y.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
Cashin, W. D., Boston, Mass.
●Dunham Co., C. A., Chicago, Ill.
Gorton Heating Corp., Cranford, N. J.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Marsh Corp., Jas. F., Chicago, Ill.
Marsh Tritrol Co., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Monash-Younker Co., Chicago, Ill.
Sterling Engineering Co., Milwaukee, Wis.
Stickle Steam Specialties Co., Indianapolis, Ind.
●Sarco Co., Inc., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

SYSTEMS, HEATING, ZONE CONTROL

●Dunham Co., C. A., Chicago, Ill.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
●Johnson Service Co., Milwaukee, Wis.
Marsh Tritrol Co., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
●Radiostat, Inc., Chicago, Ill.
Raymond Co., F. I., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

TANKS

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Bigelow Co., New Haven, Conn.
Biggs Boiler Wks. Co., Akron, O.
Bros Boiler & Mfg. Co., Wm., Minneapolis, Minn.
Brown Sheet Iron & Steel Co., St. Paul, Minn.
Brownell Co., Dayton, O.
Buffalo Tank Co., Arlington, Staten Island, N. Y.
●Burnham Boiler Corp., Irvington, N. Y.
Caldwell Co., W. E., Louisville, Ky.
Case & Son Mfg. Co., W. A., Buffalo, N. Y.
Chicago Bridge & Iron Wks., Chicago, Ill.
Columbian Steel Tank Co., Kansas City, Mo.
Connery Construction Co., Philadelphia, Pa.
Continental Diamond Fibre Co., Newark, Del.
●Curtis Refrigerating Machine Co., St. Louis, Mo.
Dahlquist Mfg. Co., Inc., Boston, Mass.
Devine Mfg. Co., Inc., J. P., Mt. Vernon, Ill.
Dillon Steam Boiler Wks., Inc., D. M., Fitchburg, Mass.
Downingtown Iron Wks., Downingtown, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Falstrom Co., Passaic, N. J.
Farquhar Co., Ltd., A. B., York, Pa.
Farrar & Trefts, Buffalo, N. Y.
●Frick Co., Waynesboro, Pa.
Gerstein & Cooper Co., South Boston, Mass.
Graver Tank & Mfg. Co., Inc., East Chicago, Ind.
Hamburg Boiler Wks., Inc., Hamburg, Pa.
Harris & Co., Arthur, Chicago, Ill.
International Boiler Wks. Co., East Stroudsburg, Pa.
International Engineering Wks., Framingham, Mass.
●Kewanee Boiler Corp., Kewanee, Ill.
Kirk & Blum Mfg. Co., Cincinnati, O.

Kisco Boiler & Engineering Co., St. Louis, Mo.
Koven & Bro., L. O., Jersey City, N. J.
Manitowoc Boiler Wks., Manitowoc, Wis.
Maxweld Corp., Brooklyn, N. Y.
Milwaukee Reliance Boiler Wks., Milwaukee, Wis.
Murray Iron Wks. Co., Burlington, Ia.
Pfaudler Co., Rochester, N. Y. (Glass lined steel)
Quaker City Iron Wks., Philadelphia, Pa.
Riverside Boiler Wks., Inc., Cambridge, Mass.
Roessing Mfg. Co., Pittsburgh, Pa.
Scaife & Sons Co., Wm. B., Oakmont, Pa.
Strandwitz & Co., Inc., Camden, N. J.
Titusville Iron Wks. Co., Titusville, Pa.
Trageser Steam Copper Wks., John, Maspeth, Long Island, N. Y.
Uniflow Mfg. Co., Erie, Pa.
Walsh-Holyoke Steam Boiler Co., Holyoke, Mass.
●Wheeling Steel Corp., Wheeling, W. Va. (Heater)
Whitlock Coil Pipe Co., Hartford, Conn.

TEMPERATURE RECORDERS

See Recorders, Temperature

TEMPERATURE REGULATORS

See Regulators, Temperature

THERMOMETERS, INDICATING, INDUSTRIAL

A. C. E. Inc., Chicago, Ill.
American Thermometer Co., St. Louis, Mo.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
G. M. Mfg. Co., New York, N. Y.
H-B Instrument Co., Philadelphia, Pa.
●Ideal Commutator Dresser Co., Sycamore, Ill.
●Illinois Testing Laboratories, Inc., Chicago, Ill.
●Johnson Service Co., Milwaukee, Wis.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Martocello & Co., Jos. A., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Palmer Co., Cincinnati (St. Bernard), O.
Philadelphia Thermometer Co., Philadelphia, Pa.
Pyrometer Instrument Co., New York, N. Y.
Scientific Instrument Co., Detroit, Mich.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

THERMOMETERS, INDICATING, REMOTE-READING

●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Builders Iron Foundry, Providence, R. I.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
●Illinois Testing Laboratories, Inc., Chicago, Ill.
●Johnson Service Co., Milwaukee, Wis.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Thwing-Albert Instrument Co., Philadelphia, Pa.
Trerice Co., H. O., Detroit, Mich.
United States Gauge Co., New York, N. Y.

THERMOMETERS, INDICATING, WALL

A. C. E. Inc., Chicago, Ill.
American Thermometer Co., St. Louis, Mo.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Electrical Research Laboratories, Warren, Pa.
Fee and Stemwedel, Inc., Chicago, Ill.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
G. M. Mfg. Co., New York, N. Y.
H-B Instrument Co., Philadelphia, Pa.
●Illinois Testing Laboratories, Inc., Chicago, Ill.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Martocello & Co., Jos. A., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
Philadelphia Thermometer Co., Philadelphia, Pa.
Rochester Mfg. Co., Inc., Rochester, N. Y.
Scientific Instrument Co., Detroit, Mich.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
United States Gauge Co., New York, N. Y.
Weston Electrical Instrument Corp., Newark, N. J.

THERMOMETERS, RECORDING

Bailey Meter Co., Cleveland, O.
●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
Moeller Instrument Co., Richmond Hill, N. Y.
●Practical Instrument Co., Chicago, Ill.
●Powers Regulator Co., Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.

THERMOSTATIC BI-METALS

See Bi-Metals, Thermostatic

THERMOSTATIC TRAPS

See Traps, Steam, Thermostatic

THERMOSTATS, DUCT TYPE

A. C. E. Inc., Chicago, Ill.
●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
Cook Electric Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Edison, Inc., Thomas A., Edison Electric Controls Div., West Orange, N. J.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
Hart Mfg. Co., Hartford, Conn.
Jefferson Electric Co., Bellwood, Ill.
●Johnson Service Co., Milwaukee, Wis.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
Philadelphia Thermometer Co., Philadelphia, Pa.
●Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
●Sarco Co., New York, N. Y.
Sheer Co., H. M., Quincy, Ill.
Spencer Thermostat Co., Attleboro, Mass.
Standard Thermometer, Inc., Boston, Mass.
Superstat Co., Springfield, Mass.

THERMOSTATS, EFFECTIVE TEMPERATURE

●Barber-Colman Co., Rockford, Ill.
●Johnson Service Co., Milwaukee, Wis.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
●Powers Regulator Co., Chicago, Ill.

THERMOSTATS, IMMERSION

●Barber-Colman Co., Rockford, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Dunn, Inc., Struthers, Philadelphia, Pa.
Edison, Inc., Thomas A., Edison Electric Controls Div., West Orange, N. J.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
Hart Mfg. Co., Hartford, Conn.
H-B Instrument Co., Philadelphia, Pa.
Jefferson Electric Co., Bellwood, Ill.
●Johnson Service Co., Milwaukee, Wis.
Leslie Co., Lyndhurst, N. J.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Spencer Thermostat Co., Attleboro, Mass.
Superstat Co., Springfield, Mass.

THERMOSTATS, REMOTE CONTROL

●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
●Detroit Lubricator Co., Detroit, Mich.
Foxboro Co., Foxboro, Mass.

●Friez & Sons, Inc., Julien P., Baltimore, Md.
Hart Mfg. Co., Hartford, Conn.
Illinois Engineering Co., Chicago, Ill.
Jefferson Electric Co., Bellwood, Ill.
●Johnson Service Co., Milwaukee, Wis.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Penn Electric Switch Co., Des Moines, Ia.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.

THERMOSTATS, ROOM OR WALL

●Automatic Products Co., Milwaukee, Wis.
●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
Cook Electric Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●General Controls Co., San Francisco, Cal.
Gleason-Avery, Inc., Auburn, N. Y.
Jefferson Electric Co., Bellwood, Ill.
●Johnson Service Co., Milwaukee, Wis.
Master Electric Co., Dayton, O.
McCorkle Co., D. H., Berkeley, Calif.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
Pioneer Heat Regulator Corp., Dayton, O.
●Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Sheer Co., H. M., Quincy, Ill.
Spencer Thermostat Co., Attleboro, Mass.
Standard Thermometer, Inc., Boston, Mass.
Superstat Co., Springfield, Mass.
United Electric Controls Co., Boston, Mass.
White Mfg. Co., St. Paul, Minn.

THERMOSTATS, SURFACE

●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
●Detroit Lubricator Co., Detroit, Mich.
Dunn, Inc., Struthers, Philadelphia, Pa.
Edison, Inc., Thomas A., Edison Electric Controls Div., West Orange, N. J.
Foxboro Co., Foxboro, Mass.
Hart Mfg. Co., Hartford, Conn.
Jefferson Electric Co., Bellwood, Ill.
McCorkle Co., D. H., Berkeley, Cal.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
●Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Sheer Co., H. M., Quincy, Ill.
Spencer Thermostat Co., Attleboro, Mass.
Superstat Co., Springfield, Mass.
United Electric Controls Co., Boston, Mass.

THERMOSTATS, TWO COMPENSATING ELEMENTS

●Bristol Co., Waterbury, Conn.
Brown Instrument Co., Div. Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
●Johnson Service Co., Milwaukee, Wis.
Leeds & Northrup Co., Philadelphia, Pa.
●Powers Regulator Co., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

THERMOSTATS, TWO TEMPERATURE OR DUAL

Automatic Reclosing Circuit Breaker Co., Columbus, O.
●Barber-Colman Co., Rockford, Ill.
●Detroit Lubricator Co., Detroit, Mich.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●General Controls Co., San Francisco, Cal.
H-B Instrument Co., Philadelphia, Pa.
Illinois Engineering Co., Chicago, Ill.
Jefferson Electric Co., Bellwood, Ill.
●Johnson Service Co., Milwaukee, Wis.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Perfex Controls Co., Milwaukee, Wis.
Pioneer Heat Regulator Corp., Dayton, O.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Superstat Co., Springfield, Mass.
Sheer Co., H. M., Quincy, Ill.

TIME SWITCHES

See Switches, Time

TOGGLE BOLTS

See Bolts, Toggle and Anchor

TONGS, PIPE

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Jarecki Mfg. Co., Erie, Pa.
●Trimont Mfg. Co., Boston, Mass.
●Walworth Co., New York, N. Y.
●Williams & Co., J. H., New York, N. Y.

TORCHES, BRAZING

Air Reduction Sales Co., New York, N. Y.
Bastian-Blessing Co., Chicago, Ill.
Bernz Co., Inc., Otto, Rochester, N. Y.
Clayton & Lambert Mfg. Co., Detroit, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Gasweld & Airway, Inc., Chicago, Ill.
●Ideal Commutator Dresser Co., Sycamore, Ill.
Imperial Brass Mfg. Co., Chicago, Ill.
Insto-Gas Corp., Detroit, Mich.
●Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.
Milburn Co., Alexander, Baltimore, Md.
Torchweld Equipment Co., Chicago, Ill.
Turner Brass Wks., Sycamore, Ill.

TOWERS, COOLING, ATMOSPHERIC

American Cooling Tower Co., Kansas City, Mo.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
●Binks Mfg. Co., Chicago, Ill.
Burhorn Co., Edwin, Hoboken, N. J.
Cooling Tower Co., Inc., New York, N. Y.
Fluor Corp., Los Angeles, Cal.
Foster Wheeler Corp., New York, N. Y.
●Lilie-Hoffmann Cooling Towers, Inc., St. Louis, Mo.
●Marley Co., Kansas City, Mo.
Penn Cooling Tower Wks., Pittsburgh, Pa.
Pennsylvania Engineering Wks., New Castle, Pa.
Schubert-Christy Corp., Affton, St. Louis, Mo.
Tippett & Wood, Phillipsburg, N. J.
Water Cooling Tower Co., Chicago, Ill.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

TOWERS, COOLING, MECHANICAL DRAFT

●Binks Mfg. Co., Chicago, Ill.
Burhorn Co., Edwin, Hoboken, N. J.
Cooling Tower Co., Inc., New York, N. Y.
Foster Wheeler Corp., New York, N. Y.
●Lilie-Hoffmann Cooling Towers, Inc., St. Louis, Mo.
●Marley Co., Kansas City, Mo.
Penn Cooling Tower Wks., Pittsburgh, Pa.
Pennsylvania Engineering Wks., New Castle, Pa.
Research Corp., New York, N. Y.
Schubert-Christy Corp., Affton, St. Louis, Mo.
Water Cooling Tower Co., Chicago, Ill.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

TRANSMISSION DRIVES

See Drives, Chain, Flat Belt and V-Belt

TRAPS, STEAM, MECHANICAL

●American District Steam Co., North Tonawanda, N. Y.
●Anderson Co., V. D., Cleveland, O.
●Armstrong Machine Wks., Three Rivers, Mich.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
Boylston Steam Specialty Co., Chicago, Ill.
Bundy Steam Trap Co., Nashua, N. H.
Burrows Mfg. Co., F. A., York, Pa.
Cashin Co., W. D., Boston, Mass.
Cochran Corp., Philadelphia, Pa.
Coe Mfg. Co., Painesville, O.
●Crane Co., Chicago, Ill.
D. G. C. Trap & Valve Co., Inc., New York, N. Y.
Davis Regulator Co., Chicago, Ill.
d'Este Co., Julian, Charlestown, Mass.
Ellis Drier Co., Chicago, Ill.
Fisher Governor Co., Marshalltown, Ia.
Haines & Co., William S., Philadelphia, Pa.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Johnson Corp., Three Rivers, Mich.
Justus Steam Trap Co., Napanoch, N. Y.
Kaye & MacDonald, Inc., West Orange, N. J.
Keckley Co., O. C., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Klipfel Mfg. Co., Chicago, Ill.
Lytton Mfg. Co., Franklin, Va.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
McAuley Automatic Trap Co., Pittsburgh, Pa.
Milwaukee Valve Co., Milwaukee, Wis.
Morehead Mfg. Co., Detroit, Mich.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Reed Steam Equipment Co., Bridgeport, Conn.
●Sarco Co., Inc., New York, N. Y.
Schaub Engineering Co., Fred H., Chicago, Ill.
Semans & Sons, Geo. G., Pittsburgh, Pa.
Squires Co., C. E., Cleveland, O.
Stay-Rite Co., Inc., Cleveland, O.
Sterling Engineering Co., Milwaukee, Wis.
Sterling Engineering & Mfg. Corp., Hyde Park, Mass.

Stickle Steam Specialties Co., Indianapolis, Ind.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Trerice Co., H. O., Detroit, Mich.
Vapor Heating Co., New York, N. Y.
Watson & McDaniel Co., Philadelphia, Pa.
●Webster & Co., Warren, Camden, N. J.
Williams Gauge Co., Pittsburgh, Pa.
Wright-Austin Co., Detroit, Mich.
●Yarnall-Waring Co., Philadelphia, Pa.

TRAPS, STEAM, THERMOSTATIC

●American District Steam Co., North Tonawanda, N. Y.
Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Cashin Co., W. D., Boston, Mass.
D. G. C., Trap & Valve Co., Inc., New York, N. Y.
●Dunham Co., C. A., Chicago, Ill.
Haines & Co., William S., Philadelphia, Pa.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co. Milwaukee, Wis.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Simplex Heating Specialty Co., Inc., Lynchburg, Va.
Stay-Rite Co., Inc., Cleveland, O.
Sterling Engineering Co., Milwaukee, Wis.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Trane Co., La Crosse, Wis.
Vapor Heating Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

TUBES, BOILER

Bethlehem Steel Co., Bethlehem, Pa.
International Engineering Wks., Inc., Framingham, Mass.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
●National Tube Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Reading Iron Co., Philadelphia, Pa.
●Republic Steel Corp., Cleveland, O.
Steel & Tubes, Inc., Cleveland, O.
●Timken Steel & Tube Co., Canton, O.
U. S. Pipe Bending Co., San Francisco, Cal.
●Youngstown Sheet & Tube Co., Youngstown, O.

TUBING, ALLOY

Allegheny Steel Co., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa. (Aluminum)
●American Brass Co., Waterbury, Conn.
Babcock & Wilcox Co., New York, N. Y.
Bridgeport Brass Co., Bridgeport, Conn. (Bronze and silicon bronze)
Carpenter Steel Co., Reading, Pa. (Stainless steel)
Duraloy Co., Pittsburgh, Pa. (Stainless)
International Nickel Co., New York, N. Y. (Monel Metal)
●National Tube Co., Pittsburgh, Pa. (Stainless)
●Republic Steel Corp., Cleveland, O.
●Revere Brass & Copper, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn. (High brass)
Seamless Co., Long Island City, N. Y. (Flexible, seamless)
Steel and Tubes, Inc., Cleveland, O. (Stainless steel)
●Timken Steel & Tube Co., Canton, O. (Steel)
Wolverine Tube Co., Detroit, Mich. (Brass, Admiralty)

TUBING, COPPER

●American Brass Co., Waterbury, Conn.
●American Radiator Co., New York, N. Y.
American Tube Wks., New York, N. Y.
Baltimore Tube Co., Div. Revere Copper & Brass, Inc., Baltimore, Md.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Phelps Dodge Corp., New York, N. Y.
●Revere Copper & Brass, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Seamless Co., Long Island City, N. Y. (Flexible seamless)
●Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
United States Brass & Copper Co., Hyde Park, Boston, Mass.
Winchester Repeating Arms Co., New Haven, Conn.

TUBING CUTTERS

See Cutters, Pipe and Tubing

TUBING, FINNED

Bush Mfg. Co., Hartford, Conn.
G. & O. Mfg. Co., New Haven, Conn.
McCord Radiator & Mfg. Co., Detroit, Mich.
●Refrigeration Appliances, Inc., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Standard Galvanizing Co., Chicago, Ill.
Trenton Auto Radiator Wks., Trenton, N. J.
Wolverine Tube Co., Detroit, Mich.

TUBING, STEEL

Babcock & Wilcox Co., New York, N. Y.
Bethlehem Steel Co., Bethlehem, Pa.
Detroit Seamless Steel Tubes Co., Detroit, Mich.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Laclede Steel Co., St. Louis, Mo.
●National Tube Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
●Republic Steel Corp., Cleveland, O.
Seamless Co., Long Island City, N. Y. (Flexible, seamless)
South Chester Tube Co., Chester, Pa.
Spang, Chalfant & Co., Inc., Pittsburgh, Pa.
Steel and Tubes, Inc., Cleveland, O.
●Timken Steel & Tube Co., Canton, O.
Wheatland Tube Co., Philadelphia, Pa.
●Youngstown Sheet & Tube Co., Youngstown, O.

TURBINES, MECHANICAL DRIVE

●Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Carling Blower Co., Worcester, Mass.
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Murray Iron Wks. Co., Burlington, Ia.
●Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Terry Steam Turbine Co., Hartford, Conn.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Wing Mfg. Co., L. J., New York, N. Y.

2, 3 AND 4-WAY VALVES

See Valves, 2, 3 and 4-way

UNDERGROUND PIPING

See Conduit, Underground Piping

UNIONS, BRASS

Commonwealth Brass Corp., Detroit, Mich.
●Crane Co., Chicago, Ill.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
General Fittings Co. Providence, R. I.
Grabler Mfg. Co., Cleveland, O.
Hays Mfg. Co., Erie, Pa.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y.
King Union Co., Inc., Hillsgrove, R. I.
Lockport Fittings Co., Inc., Lockport, N. Y.
Lunkenheimer Co., Cincinnati, O.
Milwaukee Valve Co., Milwaukee, Wis.
Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
Phoenix Brass Fittings Corp., Irvington, N. J.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Powell Co., Wm., Cincinnati, O.
Rhode Island Fittings Co., Hillsgrove, R. I.
Standard Union Co., Lockport, N. Y.
●Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
●Walworth Co., New York, N. Y.
Weatherhead Co., Cleveland, O.

UNIONS, MALLEABLE, BRASS SEAT

Corley Co., Jersey City, N. J.
●Crane Co., Chicago, Ill.
●Dart Mfg. Co., E. M., Providence, R. I.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Inc., Thos., Burlington, N. J.
●Fairbanks Co., New York, N. Y.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
General Fittings Co., Providence, R. I.
Grabler Mfg. Co., Cleveland, O.
●Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jefferson Union Co., Lexington, Mass.
Kennedy Valve Mfg. Co., Elmira, N. Y.
King Union Co., Inc., Hillsgrove, R. I.
Lockport Fittings Co., Inc., Lockport, N. Y.
Malleable Iron Fittings Co., Branford, Conn.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Rhode Island Fittings Co., Hillsgrove, R. I.
Rockwood Sprinkler Co. of Mass., Worcester, Mass.
Standard Union Co., Lockport, N. Y.
Star Mfg. Co., Inc., Providence, R. I.
Stockham Pipe & Fittings Co., Birmingham, Ala.
United Superior Union Co., Inc., Brooklyn, N. Y.
●Walworth Co., New York, N. Y.

UNIONS, STEEL

Champion Machine & Forging Co., Cleveland, O.
●Crane Co., Chicago, Ill.
Rockwood Sprinkler Co. of Mass., Worcester, Mass.
Roessing Mfg. Co., Pittsburgh, Pa.
Vogt Machine Co., Henry, Louisville, Ky.
●Walworth Co., New York, N. Y.
●Watson-Stillman Co., Roselle, N. J.
●Youngstown Sheet & Tube Co., Youngstown, O.

UNIT AIR CONDITIONERS, COMFORT, COMPLETE

Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
American Car & Foundry Co., New York, N. Y.
•Baker Ice Machine Co., Inc., Omaha, Nebr.
Betz Unit Air Cooler Co., Kansas City, Mo.
•Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
•Burnham Boiler Corp., Irvington, N. Y.
•Carbondale Machine Corp., Harrison, N. J.
Carraway-Byrd Engineering Co., Dallas, Tex.
•Carrier Corp., Newark, N. J.
•Clarage Fan Co., Kalamazoo, Mich.
Conditionaire Unit Co., Chicago, Ill.
De La Vergne Engine Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Economy Electric Mfg. Co., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
•Fairbanks, Morse & Co., Chicago, Ill.
•Fedders Mfg. Co., Inc., Buffalo, N. Y.
General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
•Hoffman Specialty Co., Inc., Waterbury, Conn.
Howe Ice Machine Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
•Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Kisco Boiler & Egineering Co., St. Louis, Mo.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
McCormick Co., J. H., Williamsport, Pa.
Miller Conditionaire Co., Los Angeles, Cal.
Modine Mfg. Co., Racine, Wis.
•National Fan & Blower Corp., Chicago, Ill.
Nelson Corp., Herman, Moline, Ill.
Niagara Blower Co., New York, N. Y.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
Parks-Cramer Co., Fitchburg, Mass.
Peerless Ice Machine Co., Chicago, Ill.
Pamco Conditionaire Co., Chicago, Ill.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Somers, Inc., H. J., Detroit, Mich.
Standard Air Conditioning Inc., New York, N. Y.
Strandwitz & Co., Inc., Camden, N. J.
•Sturtevant Co., B. F., Boston, Mass.
Surface Combustion Corp., Toledo, O.
Syncromatic Air Conditioning Corp., Milwaukee, Wis.
Thatcher Co., Newark, N. Y.
Thermal Units Mfg. Co., Chicago, Ill.
•Trane Co., La Crosse, Wis.
Unified Air Conditioner Co., Duluth, Minn.
•Unit Heater & Cooler Co., Wausau, Wis.
United States Radiator Corp., Detroit, Mich.
Viking Air Conditioning Corp., Cleveland, O.
•Westinghouse Electric & Mfg. Co., Mansfield, O.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
XL Refrigerating Co., Inc., Chicago, Ill.
•York Ice Machinery Corp., York, Pa.
•Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, INDUSTRIAL PROCESSING, COMPLETE

Air Devices Corp., Chicago, Ill.
Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
Anetsberger Bros., Chicago, Ill.
•Baker Ice Machine Co., Inc., Omaha, Nebr.
Betz Unit Air Cooler Co., Kansas City, Mo.
•Buffalo Forge Co., Buffalo, N. Y.
•Carbondale Machine Corp., Harrison, N. J.
Carraway-Byrd Engineering Co., Dallas, Tex.
•Carrier Corp., Newark, N. J.
•Clarage Fan Co., Kalamazoo, Mich.
Conditionaire Unit Co., Chicago, Ill.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Economy Equipment Co., Inc., Chicago, Ill.
Electrovent Fan & Mfg. Co., Chicago, Ill.
•Fairbanks, Morse & Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
•Grinnell Co., Inc., Providence, R. I.
Howe Ice Machine Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
•Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
Modine Mfg. Co., Racine, Wis.
Murray Iron Wks. Co., Burlington, Ia.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Peerless Ice Machine Co., Chicago, Ill.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Research Corp., New York, N. Y.
Ross Engineering Corp., J. O., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
Strandwitz & Co., Inc., Camden, N. J.
•Sturtevant Co., B. F., Boston, Mass.
Surface Combustion Corp., Toledo, O.
Thermal Units Mfg. Co., Chicago, Ill.
•Trane Co., La Crosse, Wis.
Unified Air Conditioner Co., Duluth, Minn.
•Unit Heater & Cooler Co., Wausau, Wis.
•Vilter Mfg. Co., Milwaukee, Wis.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
XL Refrigerating Co., Chicago, Ill.
•York Ice Machinery Corp., York, Pa.
•Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, INDUSTRIAL PROCESSING, COOLING AND DEHUMIDIFYING

Advanced Engineering Co., Philadelphia, Pa.
Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
Anetsberger Bros., Chicago, Ill.
•Baker Ice Machine Co., Inc., Omaha, Nebr.
Betz Unit Air Cooler Co., Kansas City, Mo.
•Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
•Carbondale Machine Corp., Harrison, N. J.
Carraway-Byrd Engineering Co., Dallas, Tex.
•Carrier Corp., Newark, N. J.
•Clarage Fan Co., Kalamazoo, Mich.
Conditionaire Unit Co., Chicago, Ill.
Corozone Air Conditioning Corp., Cleveland, O.
De La Vergne Engine Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Economy Equipment Co., Inc., Chicago, Ill.
•Fairbanks, Morse & Co., Chicago, Ill.
•Fedders Mfg. Co., Inc., Buffalo, N. Y.
General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
•Grinnell Co., Inc., Providence, R. I.
Howe Ice Machine Co., Chicago, Ill.
Humidi-Cooler Corp., West Haven, Conn.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
•Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
•McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
Murray Iron Works, Burlington, Ia.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Peerless Ice Machine Co., Chicago, Ill.
Perfex Radiator Co., Milwaukee, Wis.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Ross Engineering Corp., J. O., New York, N. Y.
•Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
•Trane Co. La Crosse Wis.
Unified Air Conditioner Co., Duluth, Minn.
•Unit Heater & Cooler Co. Wausau, Wis.
•Vilter Mfg. Co., Milwaukee, Wis.
XL Refrigerating Co., Chicago, Ill.
•York Ice Machinery Corp., York, Pa.
•Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, INDUSTRIAL PROCESSING, HEATING AND HUMIDIFYING

Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
Anetsberger Bros., Chicago, Ill.
Bahnson Co., Winston-Salem, N. C.
Betz Unit Air Cooler Co., Kansas City, Mo.
•Buffalo Forge Co., Buffalo, N. Y.
Carraway-Byrd Engineering Co., Dallas, Tex.
•Carrier Corp., Newark, N. J.
•Clarage Fan Co., Kalamazoo, Mich.
Columbus Humidifier Co., Columbus, O.
Conditionaire Unit Co., Chicago, Ill.
Corozone Air Conditioning Corp., Cleveland, O.
Economy Equipment Co., Inc., Chicago, Ill.
•Grinnell Co., Inc., Providence, R. I.
International Moistening Co., Providence, R. I.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
Modine Mfg. Co., Racine, Wis.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Ross Engineering Corp., J. O., New York, N. Y.
Russell Electric Co., Chicago, Ill.
Savage Arms Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.

Surface Combustion Co., Racine, Wis.
●Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Unified Air Conditioner Co., Duluth, Minn.
●Unit Heater & Cooler Co., Wausau, Wis.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

UNIT AIR COOLERS, COMFORT, COOLING AND DEHUMIDIFYING

Advanced Engineering Co., Philadelphia, Pa.
Air Devices Corp., Chicago, Ill.
Airecon Industries, Inc., Detroit, Mich.
Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
American Car & Foundry Co., New York, N. Y.
Anetsberger Bros., Chicago, Ill.
●Baker Ice Machine Co., Inc., Omaha, Nebr.
Ballantyne Co., Omaha, Nebr.
Betz Unit Air Cooler Co., Kansas City, Mo.
●Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry Co., Providence, R. I.
●Carbondale Machine Corp., Harrison, N. J.
Carraway-Byrd Engineering Co., Dallas, Tex.
●Carrier Corp., Newark, N. J.
Chicago Pump Co., Chicago, Ill.
●Clarage Fan Co., Kalamazoo, Mich.
Clark Equipment Co., Buchanan, Mich.
Conditionaire Unit Co., Chicago, Ill.
De La Vergne Engine Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.
Economy Electric Mfg. Co., Chicago, Ill.
●Fairbanks, Morse & Co., Chicago, Ill.
●Fedders Mfg. Co., Buffalo, N. Y.
General Air Conditioning Corp., Cincinnati, O.
General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
●Grinnell Co., Inc., Providence, R. I.
Hardy Mfg. Co., Inc., Dayton, O.
Howe Ice Machine Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
●Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Kool-Kleen Air Conditioner Co., Sioux City, Ia.
Larkin Refrigerating Corp., Atlanta, Ga.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Marlo Coil Co., St. Louis, Mo.
McCord Radiator & Mfg. Co., Detroit, Mich.
●McQuay, Inc., Minneapolis, Minn.
Modine Mfg. Co., Racine, Wis.
●National Fan & Blower Corp., Chicago, Ill.
Nelson Corp., Herman, Moline, Ill.
Niagara Blower Co., New York, N. Y.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
Pamco Conditionaire Co., Chicago, Ill.
Peerless Ice Machine Co., Chicago, Ill.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Reliance Refrigerating Machine Co., Chicago, Ill.
●Rempe Coil Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
●Servel, Inc., Evansville, Ind.
Standard Air Conditioning, Inc., New York, N. Y.
Syncromatic Air Conditioning Corp., Milwaukee, Wis.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Unified Air Conditioner Co., Duluth, Minn.
●Unit Heater & Cooler Co., Wausau, Wis.
●Westinghouse Electric & Mfg. Co., Mansfield, O.
Willard Metallic Crypt Co., Willard, O.
Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
XL Refrigerating Co., Chicago, Ill.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

UNIT AIR HUMIDIFIERS, COMFORT, HEATING AND HUMIDIFYING

Airtemp, Inc., Detroit, Mich.
American Blower Corp., Detroit, Mich.
Betz Unit Air Cooler Co., Kansas City, Mo.
Bryant Heater Co., Cleveland, O.
●Buffalo Forge Co., Buffalo, N. Y.
●Burnham Boiler Corp., Irvington, N. Y.
Campbell Heating Co., Des Moines, Ia.
Campbell Heating Co., E. K., Kansas City, Mo.
Carraway-Byrd Engineering Co., Dallas, Tex.
●Clarage Fan Co., Kalamazoo, Mich.
General Electric Co., Schenectady, N. Y.
●Grinnell Co., Inc., Providence, R. I.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Ilg Electric Ventilating Co., Chicago, Ill.
International Boiler Wks. Co., East Stroudsburg, Pa.
International Moistening Co., Providence, R. I.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Kool-Kleen Air Conditioner Co., Sioux City, Ia.
Lewis Air-Conditioners Inc., Minneapolis, Minn.
Maid-O-Mist, Inc., Chicago, Ill.
McCord Radiator & Mfg. Co., Detroit, Mich.
Modine Mfg. Co., Racine, Wis.
Montag Stove & Furnace Wks., Portland, Ore.
●National Fan & Blower Corp., Chicago, Ill.
Nelson Corp., Herman, Moline, Ill.
Niagara Blower Co., New York, N. Y.
Norge Heating & Conditioning Div., Borg-Warner Corp., Detroit, Mich.
Parks-Cramer Co., Fitchburg, Mass.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Russell Electric Co., Chicago, Ill.
Savage Arms Corp., New York, N. Y.
Schwitzer-Cummins Co., Indianapolis, Ind.
Smith Co., H. B., Westfield, Mass.
Somers, Inc., H. J., Detroit, Mich.
Standard Air Conditioning, Inc., New York, N. Y.
Standard Engineering Wks., Pawtucket, R. I.
Surface Combustion Corp., Toledo, O.
Syncromatic Air Conditioning Corp., Milwaukee, Wis.
Thermal Units Mfg. Co., Chicago, Ill.
●Trane Co., La Crosse, Wis.
Unified Air Conditioner Co., Duluth, Minn.
●Unit Heater & Cooler Co., Wausau, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Utica Radiator Corp., Utica, N. Y.
Western Blower Co., Seattle, Wash.
●York Ice Machinery Corp., York, Pa.
●Young Radiator Co., Racine, Wis.

UNIT HEATERS

See Heaters, Unit

UNIT VENTILATORS

See Ventilators, Unit

UNITS, WINDOW VENTILATOR AND FILTER

●American Air Filter Co., Inc., Louisville, Ky.
Amirton Co., New York, N. Y.
Burrowes Corp., Portland, Me.
Coppus Engineering Corp., Worcester, Mass.
Davies Air Filter Co., New York, N. Y.
Economy Electric Mfg. Co., Chicago, Ill.
Falstrom Co., Passaic, N. J.
Kaiseraire Products Sales Co., Chicago, Ill.
Kisco Boiler & Engineering Co., St. Louis, Mo.
National Laboratories, Inc., Boston, Mass.
Perfex Radiator Co., Milwaukee, Wis.
Reed Unit-Fans, Inc., New Orleans, La.
Schwitzer-Cummins Co., Indianapolis, Ind.
Somers, Inc., H. J., Detroit, Mich.
Standard Air Conditioning, Inc., New York, N. Y.
●Staynew Filter Corp., Rochester, N. Y.
Truscon Steel Co., Youngstown, O.
Unified Air Conditioner Co., Duluth, Minn.
●Young Radiator Co., Racine, Wis.

VACUUM GAGES

See Gages, Vacuum

VACUUM HEATING SYSTEMS

See Systems, Heating, Vacuum

VACUUM PUMPS

See Pumps, Vacuum

VACUUM RECORDERS

See Recorders, Vacuum

VALVE OPERATORS

See Operators, Valve

VALVES, ANGLE

●American Brass Co., Waterbury, Conn.
●American Radiator Co., New York, N. Y.
Belfield Co., H., Philadelphia, Pa.
Belknap Mfg. Co., Bridgeport, Conn.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Central Brass Mfg. Co., Cleveland, O.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Everlasting Valve Co., Jersey City, N. J.
●Fairbanks Co., New York, N. Y.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
Gorton Heating Corp., Cranford, N. J.
●Grinnell Co., Inc., Providence, R. I.
Hasco Valve & Machine Co., Milwaukee, Wis.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Klingerit, Inc., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Milwaukee Valve Co., Milwaukee, Wis.
Northern Indiana Brass Co., Elkhart, Ind.
Ohio Brass Co., Mansfield, O.
Ohio Injector Co., Wadsworth, O.

Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Pittsburgh Valve Foundry & Construction Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Star Brass Mfg. Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, BLOW-OFF

●American Radiator Co., New York, N. Y.
Babcock & Wilcox Co., New York, N. Y.
Barrett Machine Co., N. S. Pittsburgh, Pa.
Bordo Co., Inc., L. J., Glenside, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Eclipse Fuel Engineering Co., Rockford, Ill.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Elliott Co., Jeannette, Pa.
Everlasting Valve Co., Jersey City, N. J.
●Fairbanks Co., New York, N. Y.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Keckley Co., O. C., Chicago, Ill.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Merco Nordstrom Valve Co., Pittsburgh, Pa.
Ohio Injector Co., Wadsworth, O.
Pittsburgh Valve Fdry. & Construction Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Schutte & Koerting Co., Philadelphia, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
●Yarnall-Waring Co., Philadelphia, Pa.

VALVES, CHECK

American Hard Rubber Co., New York, N. Y. (Hard rubber)
●American Radiator Co., New York, N. Y.
Barrett, Haentjens & Co., Hazelton, Pa.
Belfield Co., H., Philadelphia, Pa.
Belknap Mfg. Co., Bridgeport, Conn.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport Pa.
Detroit Brass & Malleable Wks., Detroit, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
●Fairbanks Co., New York, N. Y.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
Foster Engineering Co., Newark, N. J.
●Grinnell Co., Inc., Providence, R. I.
Hasco Valve & Machine Co., Milwaukee, Wis.
Hoosick Engineering Co., Inc., Hoosick Falls, N. Y.
Illinois Malleable Iron Co. Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co. Elmira, N. Y.
Locke Regulator Co., Salem, Mass.
Lonergan Co., J. E., Philadelphia, Pa. (Hydraulic)
Ludlow Valve Mfg. Co., Troy, N. Y.
Luzerne Rubber Co., Trenton, N. J. (Hard rubber)
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Co., Decatur, Ill.
Ohio Brass Co., Mansfield O.
Ohio Injector Co., Wadsworth, O.
Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Ruggles-Klingemann Mfg. Co., Salem, Mass. (Bleeder type)
Schutte & Koerting Co., Philadelphia, Pa.
Smolensky Valve Co., Inc., Cleveland, O.
Star Brass Mfg. Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
●Watson-Stillman Co., Roselle, N. J.
Williams Gauge Co., Pittsburgh, Pa. (Noiseless)

VALVES, DIAPHRAGM

●American Radiator Co., New York, N. Y.
●Automatic Products Co., Milwaukee, Wis.
Belfield Co., Philadelphia, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
●Bristol Co., Waterbury, Conn.
Cash Co., A. W., Decatur, Ill.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
●General Controls Co., San Francisco, Cal., and Cleveland, O.
Illinois Engineering Co., Chicago, Ill.
●Johnson Service Co., Milwaukee, Wis.
Kieley & Mueller Co., Inc., New York, N. Y.
Locke Regulator Co., Salem, Mass.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
National Regulator Co., Chicago, Ill.
Northern Indiana Brass Co., Elkhart, Ind.
Parks-Cramer Co., Fitchburg, Mass.
Powell Co., Wm., Cincinnati, O.
●Powers Regulator Co., Chicago, Ill.
Reed Steam Equipment Co., Bridgeport, Conn.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Spence Engineering Co., Inc., Walden, N. Y.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
●Trane Co., La Crosse, Wis.
Watson & McDaniel Co., Philadelphia, Pa.
Watts Regulator Co., Lawrence, Mass.

VALVES, FLOAT

●American Radiator Co., New York, N. Y.
Atlas Valve Co., Inc., Newark, N. J.
●Automatic Products Co., Milwaukee, Wis. (Oil)
Belfield Co., H., Philadelphia, Pa.
Boylston Steam Specialty Co., Chicago, Ill.
Chase Brass & Copper Co., Waterbury, Conn.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
Eclipse Fuel Engineering Co., Rocklord, Ill.
Eddy Valve Co., Waterford, N. Y.
Foster Engineering Co., Newark, N. J.
Hasco Valve & Machine Co., Milwaukee, Wis.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Locke Regulator Co., Salem, Mass.
Ludlow Valve Mfg. Co., Troy, N. Y.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Reed Steam Equipment Co., Bridgeport, Conn.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Schaphorst, W. F., Newark, N. J.
Schutte & Koerting Co., Philadelphia, Pa.
Spence Engineering Co., Inc., Walden, N. Y.
Swartwout Co., Cleveland, O.
●Trane Co., La Crosse, Wis.
Watts Regulator Co., Lawrence, Mass.

VALVES, FORGED STEEL

Central Valve Mfg. Co., Chicago, Ill.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Henry Valve Co., Chicago, Ill.
Merco Nordstrom Valve Co., Pittsburg, Pa.
Vogt Machine Co., Henry, Louisville, Ky.

VALVES, GATE, BRASS AND BRONZE

●American Brass Co., Waterbury, Conn.
American Injector Co., Detroit, Mich.
Belknap Mfg. Co., Bridgeport, Conn.
Bordo Co., Inc., L. J., Glenside, Pa.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Detroit Brass & Malleable Wks., Detroit, Mich.
●Detroit Lubricator Co., Detroit, Mich.
Eddy Valve Co., Waterford, N. Y.
Everlasting Valve Co., Jersey City, N. J.
●Fairbanks Co., New York, N. Y.
Flagg & Co., Inc., Stanley G., Philadelphia, Pa.
Gorton Heating Corp., Cranford, N. J.
Hammond Brass Wks., Hammond, Inc.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.

Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Milwaukee Valve Co., Milwaukee, Wis.
Northern Indiana Brass Co., Elkhart, Ind.
Ohio Brass Co., Mansfield, O.
Ohio Injector Co., Wadsworth, O.
Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
Phoenix Brass Fittings Corp., Irvington, N. J.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Scott Valve Mfg. Co., Detroit, Mich.
Star Brass Mfg. Co., Boston, Mass.
●Walworth Co., New York, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, GATE, IRON BODY

●American Radiator Co., New York, N. Y.
Bordo Co., Inc., L. J., Glenside, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Eddy Valve Co., Waterford, N. Y.
Everlasting Valve Co., Jersey City, N. J.
●Fairbanks Co., New York, N. Y.
Hasco Valve & Machine Co., Milwaukee, Wis.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Pittsburgh Valve & Fittings Co., Barberton, O.
Pittsburgh Valve Foundry & Construction Corp., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Rensaeller Valve Co., Cohoes, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Scott Valve Mfg. Co., Detroit, Mich.
Semet-Solvay Engineering Corp., New York, N. Y.
●Walworth Co., New York, N. Y.
Willams Valve Co., D. T., Cincinnati, O.

VALVES, GATE, STEEL

Bordo Co., Inc., L. J., Glenside, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
Hasco Valve & Machine Co., Milwaukee, Wis.
Jenkins Bros., New York, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
McAlear Mfg. Co., Chicago, Ill.
Pittsburgh Valve Fdry. & Construction Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Schutte & Koerting Co., Philadelphia, Pa.
●Walworth Co., New York, N. Y.
Williams Valve Co., D. T., Cincinnati, O.
●Worthington Pump & Machinery Corp., Harrison, N. J.

VALVES, GLOBE, BRASS AND BRONZE

●American Brass Co., Waterbury, Conn.
American Injector Co., Detroit, Mich.
Belfield Co., H., Philadelphia, Pa.
Belknap Mfg. Co., Bridgeport, Conn.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Central Brass Mfg. Co., Cleveland, O.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chase Brass & Copper Co., Waterbury, Conn.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
●Detroit Lubricator Co., Detroit, Mich.
●Fairbanks Co., New York, N. Y.
Flagg Co., Inc., Stanley G., Philadelphia, Pa.
●Grinnell Co., Inc., Providence, R. I.
Hammond Brass Wks., Hammond, Ind.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Klingerit, Inc., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Milwaukee Valve Co., Milwaukee, Wis.
Northern Indiana Brass Co., Elkhart, Ind.
Ohio Brass Co., Mansfield, O.
Ohio Injector Co., Wadsworth, O.
Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Star Brass Mfg. Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
●Watson-Stillman Co., Roselle, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, GLOBE, IRON BODY

●American Radiator Co., New York, N. Y.
Belfield Co., H., Philadelphia, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
●Crane Co., Chicago, Ill.
Edward Valve & Mfg. Co., East Chicago, Ind.
●Fairbanks Co., New York, N. Y.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Klingerit, Inc., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
McAlear Mfg. Co., Chicago, Ill.
Ohio Injector Co., Wadsworth, O.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Star Brass Mfg. Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, GLOBE, STEEL

Belfield Co., H., Philadelphia, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Hasco Valve & Machine Co., Milwaukee, Wis.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Klingerit, Inc., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
McAlear Mfg. Co., Chicago, Ill.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Star Brass Mfg. Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Walworth Co., New York, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, LINED

American Hard Rubber Co., New York, N. Y. (Hard rubber lined)
Bordo Co., Inc., L. J., Glenside, Pa. (Lead, copper, tin, etc.)
Goodrich Co., B. F., Akron, O. (Rubber lined)
Lead Lined Iron Pipe Co., Wakefield, Mass. (Lead or tin)
Jenkins Bros., New York, N. Y. (tin)
National Lead Co., New York, N. Y.
Northern Indiana Brass. Co., Elkhart, Ind. (Tinned)
Pfaudler Co., Rochester, N. Y. (Glass lined)
Resisto Pipe & Valve Co., East Cambridge, Mass. (Lead)

VALVES, MIXING, STEAM AND WATER

Fulton Sylphon Co., Knoxville, Tenn.
●Johnson Service Co., Milwaukee, Wis.
Lawler Automatic Controls, Inc., Mount Vernon, N. Y.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Sterling Engineering Co., Milwaukee, Wis.

VALVES, MOTOR OPERATED

Automatic Temperature Control Co., Inc., Philadelphia, Pa.
●Barber-Colman Co., Rockford, Ill.
●Bristol Co., Waterbury, Conn.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Cutler-Hammer, Inc., Milwaukee, Wis.
Darling Valve & Mfg. Co., Williamsport, Pa.
Davis Regulator Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Eddy Valve Co., Waterford, N. Y.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
●Fairbanks Co., New York, N. Y.
Foster Engineering Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●General Controls Co., San Francisco, Cal., and Cleveland, O.
General Electric Co., Schenectady, N. Y.
Hasco Valve & Machine Co., Milwaukee, Wis.
Illinois Engineering Co., Chicago, Ill.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kieley & Mueller, Inc., New York, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.

Ruggles-Klingemann Mfg. Co., Salem, Mass.
●Sarco Co., Inc., New York, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Shallcross Controls, Inc., Milwaukee, Wis.
Sterling Engineering Co., Milwaukee, Wis.
●Taylor Instrument Companies, Rochester, N. Y.
Vogt Machine Co., Henry, Louisville, Ky.
●Walworth Co., New York, N. Y.

VALVES, NEEDLE

Central Brass Mfg. Co., Cleveland, O.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
●Detroit Lubricator Co., Detroit, Mich.
Edward Valve & Mfg. Co., East Chicago, Ind.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Milwaukee Valve Co., Milwaukee, Wis.
Ohio Injector Co., Wadsworth, O.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
●Walworth Co., New York, N. Y.

VALVES, PLUG

Barrett, Haentjens & Co., Hazelton, Pa.
Barrett Machine Co., N. S., Pittsburgh, Pa.
Bordo Co., Inc., L. J., Glenside, Pa.
Chapman Valve Mfg. Co. Indian Orchard, Mass.
●Crane Co., Chicago, Ill.
Eddy Valve Co., Waterford, N. Y.
●Fairbanks Co., New York, N. Y.
Hasco Valve & Machine Co., Milwaukee, Wis.
Henry Valve Co., Chicago, Ill.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jenkins Bros., New York, N. Y.
Klingerit, Inc., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Merco Nordstrom Valve Co., Pittsburgh, Pa. (Lubricated)
Mueller Co., Decatur, Ill.
Ohio Injector Co., Wadsworth, O.
Pittsburgh Brass Mfg. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
●Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
●Walworth Co., New York, N. Y.

VALVES, PRESSURE REDUCING AND REGULATING

●American District Steam Co., North Tonawanda, N. Y.
●American Radiator Co., New York, N. Y.
Atlas Valve Co., Inc., Newark, N. J.
Bailey Meter Co., Cleveland, O.
Beaton & Cadwell Mfg. Co., New Britain, Conn.
Belfield Co., H., Philadelphia, Pa.
Bell & Gossett Co., Chicago, Ill.
Boylston Steam Specialty Co., Chicago, Ill.
Cash Co., A. W., Decatur, Ill.
Central Brass Mfg. Co., Pittsburgh, Pa.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
Defender Automatic Regulator Co., St. Louis, Mo.
d'Este Co., Julian, Charlestown, Mass.
●Dunham Co., C. A., Chicago, Ill.
Eclipse Fuel Engineering Co., Rockford, Ill.
Fisher Governor Co., Marshalltown, Ia.
Foster Engineering Co., Newark, N. J.
Fulton Sylphon Co., Knoxville, Tenn.
Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.
Hoosick Engineering Co., Inc., Hoosick Falls, N. Y.
Illinois Engineering Co., Chicago, Ill.
Keckley Co., O. C., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Klipfel Mfg. Co., Chicago, Ill.
Leslie Co., Lyndhurst, N. J.
Locke Regulator Co., Salem, Mass.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Norgren Co., Inc., C. A., Denver, Colo.
●Powers Regulator Co. Chicago, Ill.
Republic Flow Meters Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Shallcross Controls, Inc., Milwaukee, Wis.
Spence Engineering Co., Inc., Walden, N. Y.
Squires Co., C. E., Cleveland, O.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Sterling Engineering Co., Milwaukee, Wis.
Stickle Steam Specialties Co., Indianapolis, Ind.
Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.
Trerice Co., H. O., Detroit, Mich.
Tryco Products, Inc., Westfield, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Watts Regulator Co., Lawrence, Mass.
●Webster & Co., Warren, Camden, N. J.

VALVES, RADIATOR, AIR

●American Radiator Co., New York, N. Y.
Anderson Products Inc., Cambridge, Mass.
Beaton & Cadwell Mfg. Co., New Britain, Conn.
Beaton & Corbin Mfg. Co., Southington, Conn.
●Burnham Boiler Corp., Irvington, N. Y.
Chicago Specialty Mfg. Co., Chicago, Ill.
●Crane Co., Chicago, Ill.
Dole Valve Co., Chicago, Ill.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Jarecki Mfg. Co., Erie, Pa.
Keeney Mfg. Co., Newington, Conn.
Little Mfg. Co., M. S., Hartford, Conn.
Maid-O-Mist, Inc., Chicago, Ill.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Murdock Mfg. & Supply Co., Cincinnati, O.
National Metal Products Corp., Chicago, Ill.
New York Air Valve Corp., New York, N. Y.
Russell & Co., W. A., New York, N. Y.
Slater Mfg. Co., Wakefield, Mass.

VALVES, RADIATOR, AUTOMATIC TEMPERATURE CONTROL, ELECTRIC

●Barber-Colman Co., Rockford, Ill.
Electric Valve Mfg. Co., Inc., New York, N. Y.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
●Sarco Co., Inc., New York, N. Y.
●Taylor Instrument Companies, Rochester, N. Y.

VALVES, RADIATOR, AUTOMATIC TEMPERATURE CONTROL, PNEUMATIC

●Johnson Service Co., Milwaukee, Wis.
National Regulator Co., Chicago, Ill.
●Powers Regulator Co., Chicago, Ill.
●Taylor Instrument Companies, Rochester, N. Y.

VALVES, RADIATOR, AUTOMATIC TEMPERATURE CONTROL, SELF-CONTAINED

Fulton Sylphon Co., Knoxville, Tenn.
Lawler Automatic Controls, Inc., Mount Vernon, N. Y.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
●Powers Regulator Co., Chicago, Ill.
Sterling Engineering Co., Milwaukee, Wis.
●Taylor Instrument Companies, Rochester, N. Y.
●Trane Co., La Crosse, Wis.
●Webster & Co., Warren, Camden, N. J.

VALVES, RADIATOR, STEAM AND HOT WATER

●American Radiator Co., New York, N. Y.
Belfield Co., H., Philadelphia, Pa.
Belknap Mfg. Co., Bridgeport, Conn.
●Burnham Boiler Corp., Irvington, N. Y.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.
Commonwealth Brass Corp., Detroit, Mich.
Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
●Detroit Lubricator Co., Detroit, Mich.
●Dunham Co., C. A., Chicago, Ill.
●Fairbanks Co., New York, N. Y.
Fulton Sylphon Co., Knoxville, Tenn.
Gorton Heating Corp., Cranford, N. J.
●Grinnell Co., Inc., Providence, R. I.
Haines & Co., William S., Philadelphia, Pa.
Hammond Brass Wks., Hammond, Ind.
●Hoffman Specialty Co., Waterbury, Conn.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Bros., New York, N. Y
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Ohio Brass Co., Mansfield, O.
Ohio Injector Co., Wadsworth, O.
Ohio Pattern Wks. & Fdry. Co., Eureka Valve Div., Cincinnati, O.
Pierce, Butler Radiator Corp., Syracuse, N. Y.
Powell Co., Wm., Cincinnati, O.
●Powers Regulator Co., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
Sterling Engineering Co., Milwaukee, Wis.
Stickle Steam Specialties Co., Indianapolis, Ind.
●Trane Co., La Crosse, Wis.
●Walworth Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

VALVES, RADIATOR, STEAM AND HOT WATER, MODULATING

●American District Steam Co., North Tonawanda, N. Y.
●American Radiator Co., New York, N. Y.
Barnes & Jones, Inc., Boston, Mass.
Belknap Mfg. Co., Bridgeport, Conn.
Capitol Brass Div., Bohn Aluminum & Brass Corp., Detroit, Mich.

Cashin Co., W. D., Boston, Mass.
Commonwealth Brass Corp., Detroit, Mich.
●Crane Co., Chicago, Ill.
D. G. C. Trap & Valve Co., Inc., New York, N. Y.
●Detroit Lubricator Co., Detroit, Mich.
●Dunham Co., C. A., Chicago, Ill.
Fulton Syphon Co., Knoxville, Tenn.
Gorton Heating Corp., Cranford, N. J.
Haines & Co., William S., Philadelphia, Pa.
●Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Marsh Corp., Jas. P., Chicago, Ill.
Marsh Valve Co., Dunkirk, N. Y.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Ohio Brass Co., Mansfield, O.
Ohio Pattern Wks. & Foundry Co., Eureka Valve Div., Cincinnati, O.
●Sarco Co., Inc., New York, N. Y.
Simplex Heating Specialty Co., Inc., Lynchburg, Va.
Stay-Rite Co., Inc., Cleveland, O.
Sterling Engineering Co., Milwaukee, Wis.
●Trane Co., La Crosse, Wis.
Vapor Heating Co., New York, N. Y.
●Webster & Co., Warren, Camden, N. J.

VALVES, REFRIGERATION (ANGLE, CHECK, GATE, GLOBE, NEEDLE, RELIEF)

●Crane Co., Chicago, Ill.
●Electrimatic Corp., Chicago, Ill.
●Frick Co., Waynesboro, Pa.
Henry Valve Co., Chicago, Ill.
Kerotest Mfg. Co., Pittsburgh, Pa.
Peerless Ice Machine Co., Chicago, Ill.
Perfection Refrigeration Parts Co., Harvey, Ill.
Triumph Ice Machine Co., Cincinnati, O.
●Vilter Mfg. Co., Milwaukee, Wis.
Voss, Inc., J. H. H., New York, N. Y.
XL Refrigerating Co., Chicago, Ill.
●York Ice Machinery Corp., York, Pa.

VALVES, REFRIGERATION, EXPANSION, CONSTANT PRESSURE

●Alco Valve Co., St. Louis, Mo.
American Injector Co., Detroit, Mich.
●Automatic Products Co., Milwaukee, Wis.
Cash Co., A. W., Decatur, Ill.
●Detroit Lubricator Co., Detroit, Mich.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
Foster Engineering Co., Newark, N. J.
●Frick Co., Waynesboro, Pa.
Kerotest Mfg. Co., Pittsburgh, Pa.
Mercoid Corp., Chicago, Ill.
Peerless Ice Machine Co., Chicago, Ill.
Perfection Refrigeration Parts Co., Harvey, Ill.
●Taylor Instrument Companies, Rochester, N. Y.
Triumph Ice Machine Co., Cincinnati, O.
Vogt Machine Co., Henry, Louisville, Ky.
X L Refrigerating Co., Chicago, Ill.

VALVES, REFRIGERATION, EXPANSION, THERMOSTATIC

●Alco Valve Co., Inc., St. Louis, Mo.
American Injector Co., Detroit, Mich.
●Automatic Products Co., Milwaukee, Wis.
●Detroit Lubricator Co., Detroit, Mich.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
Mayson Mfg. Co., Inc., Detroit, Mich.
Mercoid Corp., Chicago, Ill.
Peerless Ice Machine Co., Chicago, Ill.
Perfection Refrigeration Parts Co., Harvey, Ill.
Spoehrer-Lange Co., St. Louis, Mo.
Sterling Engineering Co., Milwaukee, Wis.
●Taylor Instrument Companies, Rochester, N. Y.
Torrey Refrigeration Products, Los Angeles, Cal.
Voss, Inc., J. H. H., New York, N. Y.
X L Refrigerating Co., Chicago, Ill.

VALVES, REFRIGERATION, FLOAT, HIGH PRESSURE

●Alco Valve Co., Inc., St. Louis, Mo.
American Injector Co., Detroit, Mich.
●Automatic Products Co., Milwaukee, Wis.
●Fedders Mfg. Co., Inc., Buffalo, N. Y.
●Frick Co., Waynesboro, Pa.
Henry Valve Co., Chicago, Ill.
Imperial Brass Mfg. Co., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
Perfection Refrigeration Parts Co., Harvey, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
●Taylor Instrument Companies, Rochester, N. Y.
●Vilter Mfg. Co., Milwaukee, Wis.
X L Refrigerating Co., Chicago, Ill.
●York Ice Machinery Corp., York, Pa.

VALVES, REFRIGERATION, MAGNETIC STOP

●Alco Valve Co., Inc., St. Louis, Mo.
American Injector Co., Detroit, Mich.
●Automatic Products Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
Cooper Co., Clark, Philadelphia, Pa.
●Detroit Lubricator Co., Detroit, Mich.
Electric Valve Mfg. Co., Inc., New York, N. Y.
●Electrimatic Corp., Chicago, Ill.
●Frick Co., Waynesboro, Pa.
●General Controls Co., San Francisco, Cal.
Mercoid Corp., Chicago, Ill.
●Sarco Co., Inc., New York, N. Y.
X L Refrigerating Co., Chicago, Ill.

VALVES, REFRIGERATION, WATER REGULATING, PRESSURE OR TEMPERATURE ACTUATED

●Electrimatic Corp., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Shank, Cyrus, Chicago, Ill.

VALVES, RELIEF

Ashton Valve Co., Cambridge, Mass.
Beaton & Cadwell Mfg. Co., New Britain, Conn.
Boylston Steam Specialty Co., Chicago, Ill.
Cash Co., A. W., Decatur, Ill.
Central Brass Mfg. Co., Cleveland, O.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
●Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Eddy Valve Co., Waterford, N. Y.
Edward Valve & Mfg. Co., Inc., East Chicago, Ind.
Foster Engineering Co., Newark, N. J.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Locke Regulator Co., Salem, Mass.
Lonergan Co., J. E., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Marsh Corp., Jas. P., Chicago, Ill.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Co., Decatur, Ill.
Mueller Steam Specialty Co., Inc., New York, N. Y.
Penberthy Injector Co., Detroit, Mich.
Powell Co., Wm., Cincinnati, O.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Staples & Pfeiffer, Ltd., San Francisco, Cal.
Star Brass Mfg. Co., Boston, Mass.
Sterling Engineering Co., Milwaukee, Wis.
Swartwout Co., Cleveland, O.
Tryco Products, Inc., Westfield, Mass.
●Watson-Stillman Co., Roselle, N. J.
Watts Regulator Co., Lawrence, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

VALVES, SOLDER JOINT

●American Brass Co., Waterbury, Conn.
Bordo Co., Inc., L. J., Glenside, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
●Crane Co., Chicago, Ill.
Imperial Brass Mfg. Co., Chicago, Ill.
Jenkins Bros., New York, N. Y.
Northern Indiana Brass Co., Elkhart, Ind.
Powell Co., Wm., Cincinnati, O.
●Streamline Pipe & Fittings Div., Mueller Brass Co., Port Huron, Mich.
●Walworth Co., New York, N. Y. (Brazed)

VALVES, SOLENOID

●Alco Valve Co., Inc., St. Louis, Mo.
Anderson Products, Inc., Cambridge, Mass.
●Automatic Products Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
●Barber-Colman Co., Rockford, Ill.
Belfield Co., H., Philadelphia, Pa.
Columbus Humidifier Co., O.
Cooper Co., Clark, Philadelphia, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
Davis Regulator Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
Electric Valve Mfg. Co., Inc., New York, N. Y.
●Electrimatic Corp., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
●Frick Co., Waynesboro, Pa.
●Friez & Sons, Inc., Julien P., Baltimore, Md.
●General Controls Co., San Francisco, Cal.
General Electric Co., Schenectady, N. Y.
Keckley Co., O. C., Chicago, Ill.
McCorkle Co., D. H., Berkeley, Cal.
Mercoid Corp., Chicago, Ill.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Monmouth Products Co., Cleveland, O.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Northern Indiana Brass Co., Elkhart, Ind.
Perfex Controls Co., Milwaukee, Wis.
Powell Co., Wm., Cincinnati, O.
R-S Products Corp., Philadelphia, Pa.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Russell Electric Co., Chicago, Ill.
Schutte & Koerting Co., Philadelphia, Pa.
Spence Engineering Co., Inc., Walden, N. Y.
●Sarco Co., Inc., New York, N. Y.
Supreme Electric Products Corp., Rochester, N. Y.

VALVES, 2, 3, AND 4 WAY

●Barber-Colman Co., Rockford, Ill.
Belfield Co., H., Philadelphia, Pa.
Bordo Co., Inc., Glenside, Pa.
Cash Co., A. W., Decatur, Ill.

Cooper Co., Clark, Philadelphia, Pa.
●Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
●Detroit Lubricator Co., Detroit, Mich.
●General Controls Co., San Francisco, Cal.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jarecki Mfg. Co., Erie, Pa.
●Johnson Service Co., Milwaukee, Wis.
Lunkenheimer Co., Cincinnati, O.
Merco Nordstrom Valve Co., Pittsburgh, Pa.
●Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Iowa.
Powell Co., Wm., Cincinnati, O.
●Powers Regulator Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Smolensky Valve Co., Inc., Cleveland, O.
Spence Engineering Co., Inc., Walden, N. Y.
Weatherhead Co., Cleveland, O.
Williams Valve Co., D. T., Cincinnati, O.

VAN STONE JOINTS

See Joints, Flanged, Van Stone

V-BELT DRIVES

See Drives, V-Belt

VENETIAN BLINDS

See Blinds, Venetian

VENTILATORS, MUSHROOM

American Blower Corp., Detroit, Mich.
Best Register Co., Milwaukee, Wis.
Knowles Mushroom Ventilator Co., New York, N. Y.
Mueller Furnace Co., L. J., Milwaukee, Wis.
Niagara Blower Co., New York, N. Y.
●Sturtevant Co., B. F., Boston, Mass.
●Tuttle & Bailey, Inc., New Britain, Conn.
Ventilating Products Co., Chicago, Ill.

VENTILATORS, ROOF

Accurate Mfg. Wks., Chicago, Ill.
Aeolus Dickinson Co., Chicago, Ill.
Air Controls, Inc., Cleveland, O.
●Airtherm Mfg. Co., St. Louis, Mo.
Akrat Ventilator Co., Chicago, Ill.
Allen Corp., Detroit, Mich.
American Blower Corp., Detroit, Mich.
American Foundry & Furnace Co., Bloomington, Ill.
American-Larson Ventilating Co., Pittsburgh, Pa.
Ames Co., W. R., San Francisco, Cal.
Arex Co., Chicago, Ill.
Autoforce Ventilating System, Boston, Mass.
●Autovent Fan & Blower Co., Chicago, Ill. (Power)
Burt Mfg. Co., Akron, O.
Chicago Metal Mfg. Co., Chicago, Ill.
Economy Electric Mfg. Co., Chicago, Ill.
Falstrom Co., Passaic, N. J.
Globe Ventilator Co., Troy, N. Y.
Hirschmann Co., W. F., Buffalo, N. Y.
Ilg Electric Ventilating Co., Chicago, Ill.
International Engineering, Inc., Dayton, O.
Iona Ventilator Co., Inc., Philadelphia, Pa.
Jamar Co., Walker, Duluth, Minn.
Johnson Fan & Blower Corp., Chicago, Ill.
Jordan & Co., Paul R., Indianapolis, Ind.
Kernchen Co., Chicago, Ill.
King Ventilating Co., Owatonna, Minn.
Kirk & Blum Mfg. Co., Cincinnati, O.
Kisco Boiler & Engineering Co., St. Louis, Mo.
Kleenaire Corp., Stevens Point, Wis.
Lee & Son Co., Thomas, Cincinnati, O.
Merchant & Evans Co., Philadelphia, Pa.
Myers Electric Co., Pittsburgh, Pa. (Power)
●National Fan & Blower Corp., Chicago, Ill.
Pioneer Roofing & Sheet Metal Co., Muskogee, Okla.
Reed Unit-Fans, Inc., New Orleans, La.
Robertson Co., H. H., Pittsburgh, Pa.
Royal Ventilator Co., Philadelphia, Pa.
Schoedinger, F. O., Columbus, O.
Schwitzer-Cummins Co., Indianapolis, Ind.
●Sturtevant Co., B. F., Boston, Mass. (With fan)
Swartwout Co., Cleveland, O.
Tierney Rotor Ventilator Co., Minneapolis, Minn.
Uno Ventilator Co., Cliftondale, Mass.
Viking Air Conditioning Corp., Cleveland, O.
Washburne & Co., E. G., New York, N. Y.
Western Rotary Ventilator Co., Inc., Los Angeles, Cal.
●Wing Mfg. Co., L. J., New York, N. Y.

VENTILATORS, UNIT

Economy Electric Mfg. Co., Chicago, Ill.
Johnson Fan & Blower Corp., Chicago, Ill.
●National Fan & Blower Corp., Chicago, Ill.
Nelson Corp., Herman, Moline, Ill.
●Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.
New York Blower Co., Chicago, Ill.
Peerless Unit Ventilation Co., Inc., Bridgeport, Conn.
●Sturtevant Co., B. F., Boston, Mass.
●Trane Co., La Crosse, Wis.

VISCOUS LIQUID PUMPS

See Pumps, Viscous Liquids

VISES, PIPE

Armstrong Bros. Tool Co., Chicago, Ill.
Armstrong Mfg. Co., Bridgeport, Conn.
Athol Machine & Foundry Co., Chicago, Ill.
Erie Tool Wks., Erie, Pa.
Jarecki Mfg. Co., Erie, Pa.
Hollands Mfg. Co., Erie, Pa.
Nye Tool & Machine Wks., Chicago, Ill.
●Oster Mfg. Co., Cleveland, O.
●Ridge Tool Co., Elyria, O.
Toledo Pipe Threading Machine Co., Toledo, O.
●Trimont Mfg. Co., Roxbury, Mass.
Vanderman Mfg. Co., Willimantic, Conn.
●Walworth Co., New York, N. Y.
●Williams & Co., J. H., New York, N. Y.
Yost Mfg. Co., Meadville, Pa.

VISE STANDS

See Stands, Vise

WALL THERMOSTATS

See Thermostats, Room or Wall

WARM AIR FURNACES

See Furnaces, Warm Air

WASHERS, AIR

American Blower Corp., Detroit, Mich.
Ames Co., W. R., San Francisco, Cal.
●Autovent Fan & Blower Co., Chicago, Ill.
Bayley Blower Co., Milwaukee, Wis.
Ballantyne Co., Omaha, Nebr.
Betz Unit Air Cooler Co., Kansas City, Mo.
Bishop & Babcock Sales Co., Cleveland, O.
Blower Application Co., Milwaukee, Wis.
Bubar, Hudson H., New York, N. Y.
●Buffalo Forge Co., Buffalo, N. Y.
●Carrier Corp., Newark, N. J.
●Clarage Fan Co., Kalamazoo, Mich.
Electrovent Fan & Mfg. Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Montag Stove & Furnace Wks., Portland, Ore.
Mueller Furnace Co., L. J., Milwaukee, Wis.
●National Fan & Blower Corp., Chicago, Ill.
New York Blower Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Northern Blower Co., Cleveland, O.
Nugent Sons, Inc., Thos., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Penn Cooling Tower Wks., Pittsburgh, Pa.
Peterson Freezem Mfg. Co., Kansas City, Mo.
Spray Engineering Co., Somerville, Mass.
Stilphen Engineering & Mfg. Co., C. A., Denver, Colo.
Strandwitz & Co., Inc., Camden, N. J.
●Sturtevant Co., B. F., Boston, Mass.
Supreme Heater & Ventilating Corp., St. Louis, Mo.
●Trane Co., La Crosse, Wis.
●Unit Heater & Cooler Co., Wausau, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Utility Fan & Mfg. Co., Los Angeles, Cal.
●Vilter Mfg. Co., Milwaukee, Wis.
Western Blower Co., Seattle, Wash.
●York Ice Machinery Corp., York, Pa.

WATER CHILLERS

See Exchangers, Heat

WATER HEATERS

See Heaters, Water

WATER METERS

See Meters, Water

WATER TREATMENT

American Hydrozone Co., Inc., New York, N. Y.
Aquatic Chemical & Metallurgical Engineers, Inc., New York, N. Y.
Bird-Archer Co., New York, N. Y.
Builders Iron Foundry, Providence, R. I.
Dampney Co. of America, Boston, Mass.
Ferro-Nil Corp., New York, N. Y.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.
Haering Co., D. W., Chicago, Ill.
Hagan Corp., Pittsburgh, Pa.
Metropolitan Refining Co., Long Island City, N. Y.
Permutit Co., New York, N. Y.
Refinite Co., Omaha, Neb.
R. U. V. Engineering Corp., New York, N. Y.
Uniflow Mfg. Co., Erie, Pa.

WATER VAPOR REFRIGERATION

See Compressors, Refrigerating, Centrifugal and Compressors, Refrigerating, Steam Jet

WEATHER STRIPS, METAL

All Metal Weatherstrip Co., Chicago, Ill.
Athey Co., Chicago, Ill.
Burrowes Corp., Portland, Me.
Chamberlain Metal Weather Strip Co., Detroit, Mich.
Higgin Mfg. Co., Newport, Ky.
Monarch Metal Weatherstrip Co., St. Louis, Mo.
Northern Weatherstrip Co., Duluth, Minn.
Vento Steel Sash Co., Muskegon, Mich.
Yardley Screen & Weather Strip Corp., Columbus, O.

WELDERS, ARC

Adams Co., J. D., Indianapolis, Ind.
Air Reduction Sales Co., New York, N. Y.
Alter-Arc Mfg. Co., Lawton, Okla.
Burke Electric Co., Erie, Pa.
Commonwealth Mfg. Corp., Cincinnati, O.
Economy Electric Mfg. Co., Chicago, Ill.
Eisler Electric Corp., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Equipment Co., Wichita, Kan.
Giant Grip Mfg. Co., Oshkosh, Wis.
Hammett Mfg. Co., Kansas City, Mo.
Harnischfeger Corp., Milwaukee, Wis.
Hobart Bros. Co., Troy, O.
Hollup Corp., Chicago, Ill.
Ideal Electric & Mfg. Co., Mansfield, O.
Imperial Electric Co., Akron, O.
Lincoln Electric Co., Cleveland, O.
Maple Valley Mfg. Co., Mapleton, Ia.
Master Welders, Kansas City, Mo.
Miller Electric Mfg. Co., Appleton, Wis.
Owen-Dyneto Corp., Syracuse, N. Y.
Tatro Bros., Inc., Decorah, Ia.
Una Welding, Inc., E. Cleveland, O.
Universal Power Corp., Cleveland, O.
Vulcan Arc Welder Mfg. Co., St. Louis, Mo.
● Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Will-Weld Mfg. Co., Inc., Omaha, Neb.
Wilson Welder & Metals Co., Inc., North Bergen, N. J.

WELDERS, SPOT

Commonwealth Mfg. Corp., Cincinnati, O.
Eisler Electric Corp., Newark, N. J.
General Electric Co., Schenectady, N. Y.
Hammett Mfg. Co., Kansas City, Mo.

WELDING AND CUTTING APPARATUS, OXY-ACETYLENE

Air Reduction Sales Co., New York, N. Y.
Bastian-Blessing Co., Chicago, Ill.
Carbo-Oxygen Co., Pittsburgh, Pa.
Gasweld & Airway, Inc., Chicago, Ill.
Harris Calorific Co., Cleveland, O.
Imperial Brass Mfg. Co., Chicago, Ill.
● Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.
Milburn Co., Alexander, Baltimore, Md.
● Oster Mfg. Co., Cleveland, O.
Modern Engineering Co., St. Louis, Mo.
Sight Feed Generator Co., Richmond, Ind.
Smith Welding Equipment Co., Minneapolis, Minn.
Torchweld Equipment Co., Chicago, Ill.

WELDING ROD

See Rod, Welding

WHEELS, BLOWER

Air Controls, Inc., Cleveland, O.
American Blower Corp., Detroit, Mich.
● Autovent Fan & Blower Co., Chicago, Ill.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Champion Blower & Forge Co., Lancaster, Pa.
● Clarage Fan Co., Kalamazoo, Mich.
Janette Mfg. Co., Chicago, Ill.
● National Fan & Blower Corp., Chicago, Ill.
New York Blower Co., Chicago, Ill.
Peerless Electric Co., Warren, O.
Schwitzer-Cummins Co., Indianapolis, Ind.
● Sturtevant Co., B. F., Boston, Mass.
● Torrington Mfg. Co., Torrington, Conn.
Viking Air Conditioning Corp., Cleveland, O.

WINDOW VENTILATOR AND FILTER UNITS

See Units, Window Ventilator and Filter

WINDOW WEATHERSTRIP

See Weatherstrip, Window, Metal

WOOD PIPE

See Pipe, Wood

WRENCHES, PIPE

American Pipe Tool Co., Chicago, Ill.
Armstrong Bros. Tool Co., Chicago, Ill.
Bernz Co., Inc., Otto, Rochester, N. Y.
Blackhawk Mfg. Co., Milwaukee, Wis. (Socket type)
Erie Tool Wks., Erie, Pa.
Greene, Tweed & Co., New York, N. Y.
International Nutype Tool Corp., Oswego, N. Y.
Peck, Stow & Wilcox Co., Southington, Conn.
● Ridge Tool Co., Elyria, O.
● Trimont Mfg. Co., Boston, Mass.
U. S. Hame Co., Buffalo, N. Y.
● Williams & Co., J. H., New York, N. Y.
● Walworth Co., New York, N. Y.

WROUGHT IRON PIPE

See Pipe, Wrought Iron

ZINC SHEETS

See Sheets, Zinc

ZONE CONTROLS

See Systems, Heating, Zone Control

DIRECTORY SECTION
HEATING, PIPING AND AIR CONDITIONING EQUIPMENT FOR INDUSTRY AND LARGE BUILDINGS
PART 3—TRADE NAMES

A

A. B. C.—Ventilators. American Blower Corp., Detroit, Mich.

Abrasoweld—Electrodes. Lincoln Electric Co., Cleveland, O.

A. C. M. E.—Compounds. Aquatic Chemical & Metallurgical Engineers, New York, N. Y.

A-P—Humidistats, damper operators, regulators, relays, thermostats, valves. Automatic Products Co., Milwaukee, Wis.

ARRC — Couplings, fittings. Union Metal Wks. Inc., Chelsea, Mass.

Absorbex—Insulation. Thermax Div., Northwest Magnesite Co., Pittsburgh, Pa.

Ace—Pipe, pipe and fittings, valves, pumps. American Hard Rubber Co., New York, N. Y.

Acme—Boilers. Titusville Iron Wks. Co., Titusville, Pa.

Acousti-Vent—Insulation. Burgess Battery Co., Chicago, Ill.

Adco—Unit heaters, unit air conditioners, unit air coolers. Air Devices Corp., Chicago, Ill.

Adsco—Conduit, covering, joints, meters, regulators, valves. American District Steam Co., North Tonawanda, N. Y.

Adsco-Becker—Pumps. American District Steam Co., North Tonawanda, N. Y.

Aeracool—Blades, fans, ventilators. Myers Electric Co., Pittsburgh, Pa.

Aeratherm—Thermostats. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Aeriet—Fans, unit heaters. Air Devices Corp., Chicago, Ill.

Aero—Radiation. National Radiator Corp., Johnstown, Pa.

Aero-Art—Radiation. National Radiator Corp., Johnstown, Pa.

Aerocrat—Fans, humidifiers, washers. Ames Co., W. R., San Francisco, Cal.

Aeroplex—Fans. Bayley Blower Co., Milwaukee, Wis.

Aerovalve—Ventilators. Knowles Mushroom Ventilator Co., New York, N. Y.

Affco—Dampers, grilles, louvers and shutters, ventilators. American Foundry & Furnace Co., Bloomington, Ill.

Air-Acoustic—Insulation. Johns-Manville, New York, N. Y.

Airblanket—Unit heaters. Airtherm Mfg. Co., St. Louis, Mo.

Aireo—Electrodes, welding rod. Air Reduction Sales Co., New York, N. Y.

Aireo-DB—Gages, regulators, torches, welding and cutting apparatus. Air Reduction Sales Co., New York, N. Y.

Airfoil—Fans. Aerovent Fan Co., Piqua, O.

Airgard—Window ventilator and filter units. American Air Filter Co., Inc., Louisville, Ky.

Air-Gas-Pop — Valves. Lunkenheimer Co., Cincinnati, O.

Airguide—Hygrometers, thermometers. Fee and Stemwedel, Inc., Chicago, Ill.

Airline—Grilles, registers. Tuttle & Bailey, Inc., New Britain, Conn.

Air-Master—Grilles, louvers and shutters, registers. Waterloo Register Co., Waterloo, Ia.

Airmat—Air filters. American Air Filter Co., Inc., Louisville, Ky.

Airmat Arrester—Dust collectors. American Air Filter Co., Inc., Louisville, Ky.

Airmeter—Hygrometers. Johnson Tool Co., East Providence, R. I.

Airmixt Sally Mander—Heaters. Williams, Inc., F. C., Dearborn, Mich.

Air-O-Liser—Ventilators. Trane Co., La Crosse, Wis.

Air-O-Matic—Unit air conditioners, unit air coolers. Williams Oil-O-Matic Corp., Bloomington, Ill.

Air-O-Vent—Ventilators. Trane Co., La Crosse, Wis.

Airplex—Air filters. Davies Air Filter Co., New York, N. Y.

Airtrol—Unit air conditioners. McCormick & Co., J. H., Williamsport, Pa.

Airvector—Unit heaters. Airtherm Mfg. Co., St. Louis, Mo.

Akron Red—Packing. Goodrich Co., B. F., Akron, O.

Aladdin—Welders. Commonwealth Mfg. Corp., Cincinnati, O.

Alaska—Surface. Star Radiator Co., Los Angeles, Cal.

All-In-One—Tubing. Wolverine Tube Co., Detroit, Mich.

Alnor—Thermometers. Illinois Testing Laboratories, Chicago, Ill.

Alnor Velometer—Anemometers. Illinois Testing Laboratories, Chicago, Ill.

Aluminweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Always Ready—Wrenches. Williams & Co., J. H., New York, N. Y.

Always Reliable—Benders, leak detectors, torches, wrenches. Bernz Co., Inc., Otto, Rochester, N. Y.

Ambraloy—Tubing, welding rod. American Brass Co., Waterbury, Conn.

Ambroc—Welding rod. American Brass Co., Waterbury Conn.

Ameo—Humidifiers, humidistats, psychrometers, hygrometers. American Moistening Co., Providence, R. I.

Amco—Packing. Austin-Mason Co., New York, N. Y.

American—Couplings. American Flexible Coupling Co., Erie, Pa.

American—Furnaces. American Foundry & Furnace Co., Bloomington, Ill.

American—Shears. American Foundry Equipment Co., Mishawaka, Ind.

American—Dampers, grilles, louvers and shutters. American Warming & Ventilating Co., Toledo, O.

American—Humidistats, hygrometers, manometers, psychrometers, recorders, regulators, thermometers. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.

American-Marsh — Pumps. American Steam Pump Co., Battle Creek, Mich.

Anaconda—Fittings, pipe, welding rod, sheets, solder, tubing, valves. American Brass Co., Waterbury, Conn.

Ankorite—Packing. Anchor Packing Co., Philadelphia, Pa.

Anode—Electrodes. Lincoln Electric Co., Cleveland, O.

Anti-Vibro Block—Bases. Union Fibre Co., Inc., Winona, Minn.

Apex—Quadrants. Ohio Products Co., Cleveland, O.

Apex—Recorders. Uehling Instrument Co., Paterson, N. J.

Apexior—Coatings. Dampney Co. of America, Hyde Park, Boston, Mass.

Aquaseal — Cement and compounds. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Aquazone—Humidifiers. Corozone Air Conditioning Corp., Cleveland, O.

Arco—Boilers, filters, fittings, pipe, plates, pumps, radiation, regulators, systems, unit air conditioners, valves. American Radiator Co., New York, N. Y.

Arcoblast—Cooling and heating surface. American Radiator Co., New York, N. Y.

Arctic Nu-Air—Fans, grilles. U. S. Air Conditioning Corp., Minneapolis, Minn.

Arex-Austor—Roof ventilators. Arex Co. Chicago, Ill.

Arin—Louvers and shutters. Arex Co., Chicago, Ill.

Aristocrat—Registers. Auer Register Co., Cleveland, O.

Armco—Sheets. American Rolling Mill Co., Middletown, O.

Armorak—Pipe covering. Keasbey Co., Robert A., New York, N. Y.

Asbestocel—Covering. Johns-Manville, New York, N. Y.

Asco—Valves, relays, switches. Automatic Switch Co., New York, N. Y.

Ashcolite — Pipe. Allen-Sherman-Hoff Co., Philadelphia, Pa.

Ashcroft American—Gages. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.

Atlas—Dampers. Brown, Wm. P., Springfield, Mass.

Atlas—Dampers. Hampden Cornice Wks., Inc., Springfield, Mass.

Atlas—Unions. Rockwood Sprinkler Co. of Mass., Worcester, Mass.

Auto-Klean—Filters, strainers. Cuno Engineering Corp., Meriden, Conn.

Automad—Valves. Webster & Co., Warren, Camden, N. J.

Automatic Butler—Stokers. Butler Mfg. Co., Kansas City, Mo.

Autovent—Eliminators, unit air humidifiers, valves. Maid-O-Mist, Inc., Chicago, Ill.

B

B. B.—Electric motors. Brown-Brockmeyer Co., Dayton, O.

B & B—Pumps. Bishop & Babcock Sales Co., Cleveland, O.

B & C—Plates. Beaton & Corbin Mfg. Co., Southington, Conn.

B & K—Machines. Bignall & Keeler Machine Wks., Edwardsville, Ill.

B/W—Relays, switches. Bender Warrick Corp., Birmingham, Mich.

B & W—Boilers, burners, pipe, tubing, stokers, valves. Babcock & Wilcox Co., New York, N. Y.

Ballentine—Motors. Russell Electric Co., Chicago, Ill.

Balmi-Aire—Unit air humidifiers. U. S. Air Conditioning Corp., Minneapolis, Minn.

Barcol—Motors, regulators, thermostats, valves. Barber-Colman Co., Rockford, Ill.

Barnes—Cutters. Erie Tool Works, Erie, Pa.

Barry—Blocks, couplings. Dick Co., Inc., R. & J., Passaic, N. J.

Beacor—Valves. Beaton & Corbin Mfg. Co., Southington, Conn.

Belmont—Packing. Belmont Packing & Rubber Co., Philadelphia, Pa.

Benco—Oil burners. Bennett Corp., W. M., Omaha, Neb.

Bendix—Fans. Air Devices Corp., Chicago, Ill.

Bennett-Allison—Oil burners. Bennett Corp., W. M., Omaha, Neb.

Benton—Boilers. Combination Boiler Co., Benton Harbor, Mich.

Berloy—Parts. Berger Mfg. Co., Div. of Republic Steel Corp., Canton, O.

Binoc—Thermometers. Taylor Instrument Companies, Rochester, N. Y.

Bison—Boilers. Farrar & Trefts, Buffalo, N. Y.

Bloapco—Dust collectors. Blower Application Co., Milwaukee, Wis.

Blo-Matic — Stokers. Her-Born Engineering & Mfg. Co., Sandusky, O.

Blue Ribbon—Hangers or brackets, nipples, plates. Chicago Nipple Mfg. Co., Chicago, Ill.

Box—Air filters. Burt Air Filter Corp., New York, N. Y.

Branford—Unions. Malleable Iron Fittings Co., Branford, Conn.

Braze—Solder. Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.

Breeze—Fans. Buffalo Forge Co., Buffalo, N. Y.

Browning—V belts, blades. Ohio Valley Pulley Works Div., Browning Mfg. Co., Inc., Maysville, Ky.

Buckeye—Unit heaters. Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.

Bull Dog—Wrenches. Williams & Co., J. H., New York, N. Y.

Burnham-Taco — Heaters. Burnham Boiler Corp., Irvington, N. Y.

C

C-E—Boilers. Combustion Engineering Co., New York, N. Y.

CE-Skelly—Stokers. Combustion Engineering Co., Inc., New York, N. Y.

C-H—Controllers and starters, heaters, relays, switches, valves. Cutler-Hammer, Inc., Milwaukee, Wis.

CJB—Bearings. Ahlberg Bearing Co., Chicago, Ill.

C. N. I. — Pipe. Walworth Co., New York, N. Y.

C-U—Unit heaters. Surface Combustion Corp., Toledo, O.

Cadillac—Meters. Central Station Steam Co., Detroit, Mich.

Cadman—Valves. Barrett Machine Co., N. S., Pittsburgh, Pa.

Calorider—Air washers, dehumidifiers, unit air conditioners. Research Corp., New York, N. Y.

Cameo—Radiation. Weil-McLain Co., Chicago, Ill.

Capitol—Boilers, hangers or brackets, heaters, radiation, unit air conditioners. United States Radiator Corp., Detroit, Mich.

Capitol—Insulation. Standard Lime & Stone Co., Baltimore, Md.

Capitol Fincast — Radiation. United States Radiator Corp., Detroit, Mich.

Careycel—Insulation. Carey Co., Philip, Lockland, Cincinnati, O.

Carrier-Brunswick—Compressors. Carrier Corp., Newark, N. J.

Carton—Furnaces. International Heater Co., Utica, N. Y.

Casey-Hedges — Boilers. Combustion Engineering Co., Inc., New York, N. Y.

Castirnare—Electrodes. Universal Power Corp., Cleveland, O.

Celoron—Couplings. Continental Diamond Fibre Co., Newark, Del.

Celto—Electrodes, welding rod. Keasbey & Mattison Co., Ambler, Pa.

Centrimax—Meters. Leeds & Northrup Co., Philadelphia, Pa.

Chaco—Cement and compounds, boiler and radiator sealing compounds. Desolvo Mfg. Co., Pittsburgh, Pa.

Champion—Wrenches. Greene, Tweed & Co., New York, N. Y.

Charavay—Propeller fans, unit heaters. Hartzell Propeller Fan Co., New York, N. Y.

Chill-Vactor—Steam jet compressors, Croll-Reynolds Engineering Co., Inc., New York, N. Y.

Chinook—Ferrous heating surface. Bayley Blower Co., Milwaukee, Wis.

Chinookfin—Non-ferrous heating surface. Bayley Blower Co., Milwaukee, Wis.

Chromalox — Preheaters, unit heaters. Wiegand Co., Edwin L., Pittsburgh, Pa.

Chromeweld 4-6—Electrodes. Lincoln Electric Co., Cleveland, O.

Chronotherm—Thermostats. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Circle T—Switches. Trumbull Electric Co., Plainville, Conn.

CirCOOLator—Fans, ventilators. Viking Air Conditioning Corp., Cleveland, O.

Clark-Sundh — Motor controls. Clark Controller Co., Cleveland, O.

Classic—Registers. Auer Register Co., Cleveland, O.

Climate Changer—Unit air conditioners, unit air coolers. Trane Co., La Crosse, Wis.

Climate Master — Fan blades. Reed Unit-Fans, Inc., New Orleans, La.

Climax—Regulators. Kieley & Mueller, Inc., New York, N. Y.

Climax—Unions. Devlin Mfg. Co., Inc., Thos., Burlington, N. J.

Clinton — Grilles. Wickwire Spencer Steel Co., New York, N. Y.

Cloth Stocking—Dust collectors. American Air Filter Co., Inc., Louisville, Ky.

Cocheco—Belting. Williams & Son, I. B., Dover, N. H.

Coey—Cooling towers. Research Corp., New York, N. Y.

Cog-Belt—Transmission drives. Dayton Rubber Mfg. Co., Dayton, O.

Cold Stream—Surface, unit air conditioners. Baker Ice Machine Co., Inc., Omaha, Nebr.

Colonial — Registers. Auer Register Co., Cleveland, O.

Combustioneer — Stokers. Steel Products Engineering Co., Springfield, O.

Comet—Fans, unit heaters. New York Blower Co., Chicago, Ill.

Comfort—Hygrometers, psychrometers. A. C. E., Inc., Chicago, Ill.

Comfostat — Thermostats. Johnson Service Co., Milwaukee, Wis.

Compak—Valves. Commonwealth Brass Corp., Detroit, Mich.

Conco—Valves. Capitol Brass Division, Bohn Aluminum & Brass Corp., Detroit, Mich.

Condor—Belting, V belts, pipe. Manhattan Rubber Mfg., Div. of Raybestos Manhattan, Inc., Passaic, N. J.

Consolidated—Valves. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.

Control-O-Gas—Regulators. Payne Furnace & Supply Co. Beverly Hills, Cal.

Convectofin — Radiation. Commodore Heaters Corp., New York, N. Y.

Coolair—Fans. American Coolair Corp., Jacksonville, Fla.

Cop-R-Loy — Sheets. Wheeling Steel Corp., Wheeling, W. Va.

Coroaire—Heaters. Corozone Air Conditioning Corp., Cleveland, O.

Corto—Radiation. American Radiator Co., New York, N. Y.

Coxe—Boilers, stokers. Combustion Engineering Co., New York, N. Y.

Cradle Coil—Unit heaters. Trane Co., La Crosse, Wis.

Crescent—Burners. Caloroil Burner Corp., Hartford, Conn.

Crescent—Unions. Star Mfg. Co., Inc., Providence, R. I.

Cromaloy—Solder. Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.

Crown-Brand—Cement and compounds. Colebrooks Sons, Inc., W. H., Syracuse, N. Y.

Cryer—Traps and valves. D. G. C. Trap & Valve Co., Inc., New York, N. Y.

Cub—Unions. Rhode Island Fittings Co., Hillsgrove, R. I.

Curtis — Regulators, traps, valves, d'Este Co., Julian, Charlestown, Mass.

Cycloidal—Air washers. Blower Application Co., Milwaukee, Wis.

Cycloidal Atomizers — Nozzles. Blower Application Co., Milwaukee, Wis.

D

Dart—Unions. Fairbanks Co., New York, N. Y.

Decalorator — Compressors. American Blower Corp., Detroit, Mich.

Decalorator — Steam jet compressors. Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.

Deflect-O-Grille—Grilles. U. S. Air Conditioning Corp., Minneapolis, Minn.

Delco-Heat—Burners, condensers, heaters. Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, O.

Detroit LoStoker — Stokers. Detroit Stoker Co., Detroit, Mich.

Detroit UniStoker—Stokers. Detroit Stoker Co., Detroit, Mich.

Dexter—Air separators. Leavitt Machine Co., Orange, Mass.

Diamond Fibre—Gaskets. Continental Diamond Fibre Co., Newark, Del.

Diamond H — Switches, thermostats. Hart Mfg. Co., Hartford, Conn.

Dickbelt—Belting, drives. Dick Co., Inc., R. & J., Passaic, N. J.

Dickrope—Belts, drives. Dick Co., Inc., R. & J., Passaic, N. J.

Difr-enshal-Vacm — Heating systems. Dunham Co., C. A., Chicago, Ill.

Differential — Thermostats. Johnson Service Co., Milwaukee, Wis.

Dilecto—Insulation. Continental Diamond Fibre Co., Newark, Del.

Discfin—Cooling surface. General Refrigeration Sales Co., Beloit, Wis.

Disc-Loc—Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.

Domic—Heaters. Central Radiator Co., New York, N. Y.

Dominion—Gaskets, packing. Darcoid Co., Inc., New York, N. Y.

Double Diamond—Hygrometers, recorders, psychrometers. H-B Instrument Co., Philadelphia, Pa.

Double Duty—Air filters. Independent Air Filter Co., Chicago, Ill.

Double-Quick—Pipe machines. American Die & Tool Co., Reading, Pa.

Double-Seal—Copper tube fittings. Hays Mfg. Co., Erie, Pa.

Draftrite—Gages. Bacharach Industrial Instrument Co., Pittsburgh, Pa.

Drainator — Traps. Coe Mfg. Co., Painesville, O.

Dri-Cool—Unit air humidifiers. U. S. Air Conditioning Corp., Minneapolis, Minn.

Dry-Matic—Air filters. Coppus Engineering Co., Worcester, Mass.

Dry-paC—Covering. Ric-wiL Co., Cleveland, O.

Dry-Sol—Dehumidifiers. Russell Electric Co., Chicago, Ill.

Dual — Thermostats. Johnson Service Co., Milwaukee, Wis.

Dualsteel—Unions. Rockwood Sprinkler Co. of Mass., Worcester, Mass.

Dul-Kote — Sheets. Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.

Dunco—Relays, thermostats. Dunn, Inc., Struthers, Philadelphia, Pa.

Duo-Stat—Heating systems, thermostats. Johnson Service Co., Milwaukee, Wis.

Duo-Stat—Thermostats. Raymond Co., F. I., Chicago, Ill.

Duplex—Machines. Bignall & Keeler Machine Wks., Edwardsville, Ill.

Durco—Pipe. Duriron Co., Inc., Dayton, O.

Duro—Valves. Lunkenheimer Co., Cincinnati, O.

Duroline — Pipe. National Tube Co., Pittsburgh, Pa.

Dust-Stop—Air filters. Owens-Illinois Glass Co., Toledo, O.

Dustube — Dust collectors. American Foundry Equipment Co., Mishawaka, Ind.

E

EC & M—Motor controls. Electric Controller & Mfg. Co., Cleveland, O.

EKCCO—Fans. Campbell Heating Co., E. K., Kansas City, Mo.

Easy-Flo—Solder. Handy & Harman, New York, N. Y.

Easyweld—Electrodes. Universal Power Corp., Cleveland, O.

Eclipse—Governors, regulators, traps, valves. Illinois Engineering Co., Chicago, Ill.

Economizer—Cooling towers. York Ice Machinery Corp., York, Pa.

Economy—Boilers, heaters. International Heater Co., Utica, N. Y.

Economy — Registers. Auer Register Co., Cleveland, O.

Economy — Stokers. Christensen Machine Co., Salt Lake City, Utah.

Economy—Unit ventilators. Arex Co., Chicago, Ill.

Egnifo — Valves. Grinnell Co., Inc., Providence, R. I.

Electrap—Pumps. Johnson Corp., Three Rivers, Mich.

Electra-Vac—Pumps. Johnson Corp., Three Rivers, Mich.

Electromode—Electric heaters. Electric Air Heater Co., Div. American Foundry Equipment Co., Mishawaka, Ind.

Electronite — Stainless steel tubing. Steel and Tubes, Inc., Cleveland, O.

Electro-Sheet—Sheets. American Brass Co., Waterbury, Conn.

Electrozone—Ozone apparatus. Triox Engineering Co., St. Louis, Mo.

Elite—Registers. Auer Register Co., Cleveland, O.

Emco—Regulators. Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

Empire—Bolts and studs. Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.

Enco—Burners, regulators. Engineer Co., New York, N. Y.

Enduro—Pipe, sheets, tubing. Republic Steel Corp., Cleveland, O.

Enduro—Unions. Lockport Fittings Co., Inc., Lockport, N. Y.

Equalizing — Valves. Gorton Heating Corp., Cranford, N. J.

Eskimo—Surface. Star Radiator Co., Los Angeles, Cal.

Esotoo—Refrigerant. Virginia Smelting Co., West Norfolk, Va.

Eureka—Regulators, valves. Kieley & Mueller, Inc., New York, N. Y.

Evactor — Pumps. Croll-Reynolds Engineering Co., Inc., New York, N. Y.

Evalpak—Packing. Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

Evco—Valves. Electric Valve Mfg. Co., Inc., New York, N. Y.

Evenaction—Valves. Taylor Instrument Companies, Rochester, N. Y.

Everdur—Pipe, sheets, tubing, welding rod. American Brass Co., Waterbury, Conn.

Excel—Unions. Lockport Fittings Co., Inc., Lockport, N. Y.

Exhaustair—Fans. New York Blower Co., Chicago, Ill.

Eye-Hye—Gages. Reliance Gauge Column Co., Cleveland, O.

F

F & E—Stokers. Flynn & Emrich Co., Baltimore, Md.

FAB—Unions. Lockport Fittings Co., Inc., Lockport, N. Y.

FAB—Unions. Standard Union Co., Lockport, N. Y.

Fabrikated—Grilles, registers. Independent Register Co., Cleveland, O.

Fantom—Radiation. American Radiator Co., New York, N. Y.

Faragut—Packing. Darcoid Co., Inc., New York, N. Y.

Featherfin — Heating surface. Wing Mfg. Co., L. J., New York, N. Y.

Featherweight — Unit heaters. Wing Mfg. Co., L. J., New York, N. Y.

Ferrenewo—Valves. Lunkenheimer Co., Cincinnati, O.

Ferroclad—Insulation. Truscon Steel Co., Youngstown, O.

Ferrocraft—Grilles, registers. Tuttle & Bailey, Inc., New Britain, Conn.

Ferroflo—Grilles. Tuttle & Bailey, Inc., New Britain, Conn.

Ferrogrid—Registers, Tuttle & Bailey, Inc., New Britain, Conn.

Ferro-Therm — Insulation. American Flange & Mfg. Co., Inc., New York, N. Y.

Ferroweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Fiberglas — Cement, covering, insulation. Owens-Illinois Glass Co., Toledo, O.

Fibrofelt—Insulation. Union Fibre Co., Inc., Winona, Minn.

Fields—Cement and compounds. Grinnell Co., Inc., Providence, R. I.

Filmflo—Deaerators, separators. Croll-Reynolds Engineering Co., Inc., New York, N. Y.

Filtenaire — Window ventilator and filter units. Davies Air Filter Co., New York, N. Y.

Fleetweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Flexcord—Drives. Gates Rubber Co., Denver, Colo.

Flexeal—Gaskets. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Flexodisc—Expansion joints. Croll-Reynolds Engineering Co., Inc., New York, N. Y.

Flo-Klean—Filters, strainers. Cuno Engineering Corp., Meriden, Conn.

Flush Kleen—Ejectors. Chicago Pump Co., Chicago, Ill.

Forbes Syphonaire—Ventilators. Western Rotary Ventilator Co., Inc., Los Angeles, Cal.

Forcedraft—Unit air coolers. Fedders Mfg. Co., Inc., Buffalo, N. Y.

Force-Flo—Circulators, heaters, regulators. Stevens-Root Co., Chicago, Ill.

Franeke—Flexible couplings. Waldron Corp., John, New Brunswick, N. J.

Freeflo—Grilles. Trane Co., La Crosse, Wis.

"Freon"—Refrigerant. Kinetic Chemicals, Inc., Wilmington, Del.

Fretz—Nipples. Devlin Mfg. Co., Inc., Thos., Burlington, N. J.

Frevent—Valves. Russell & Co., W. A., New York, N. Y.

Fulscope — Recorders, recorder-controllers, regulators, Taylor Instrument Companies, Rochester, N. Y.

Frigitower—Cooling towers. Schubert-Christy Corp., St. Louis, Mo.

fYBa—Motor operated valves. Barber-Colman Co., Rockford, Ill.

Fyr-Feeder — Stokers. American Coal Burner Co., Chicago, Ill.

G

G & M—Stokers. Stokermatic Co., Salt Lake City, Utah.

Gallery — Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.

Gardnerench—Tongs. Billings & Spencer Co., Hartford, Conn.

Gas Era—Boilers. L. J. Mueller Furnace Co., Milwaukee, Wis.

Gast—Filters, separators. Johnson Corp., Three Rivers, Mich.

Gasteam—Radiation. Clow, Jas. B. & Sons, Chicago, Ill.

Geddes—Radiation. Fowler & Wolfe Radiator Co., Norristown, Pa.

Gemware — Hygrometers, psychrometers, thermometers. G. M. Mfg. Co., New York, N. Y.

Genasco—Cement and compounds, insulation. Barber Co., Inc., Philadelphia, Pa.

Genuine Detroit—Gages, humidistats, operators, switches, thermostats, valves. Detroit Lubricator Co., Detroit, Mich.

Genuine Stillson—Wrenches. Walworth Co., New York, N. Y.

Geyser—Water heaters. Thatcher Co., Newark, N. J.

Giant—Unit heaters, Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.

Giant Nite—Fans. Russell Electric Co., Chicago, Ill.

Gilbarco—Burners, heaters. Gilbert & Barker Mfg. Co., Springfield, Mass.

Gilt Edge—Belting. Rhoads & Sons, J. E., Wilmington, Del.

Gimco—Insulation. General Insulating & Mfg. Co., Alexandria, Ind.

Gland-Pakt — Expansion joints. Yarnall-Waring Co., Philadelphia, Pa.

Gloco Red Band—Water heaters. Glore Sales Corp., Evins F., New York, N. Y.

Goetzerit—Packing. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Gohi—Sheets. Newport Rolling Mill Co., Newport, Ky.

Goss—Humidistats. Ripley Co., W. R. Tacoma, Wash.

Gothic — Radiation. Thatcher Co., Newark, N. J.

Green—Stokers. Combustion Engineering Co., Inc., New York, N. Y.

Grid—Unit heaters. Unit Heater & Cooler Co., Wausau, Wis.

Gulfsteel—Electrodes, sheets. Gulf States Steel Co., Birmingham Ala.

Gun-Pakt—Expansion joints. Yarnall-Waring Co., Philadelphia, Pa.

Guthfan—Fans. Guth Co., Edwin F., St. Louis, Mo.

H

H-B—Boilers. Smith Co., H. B., Westfield, Mass.

H & C—Dampers, grilles, registers. Hart & Cooley Mfg. Co., Chicago, Ill.

H & C—Regulators. Watson & McDaniel Co., Philadelphia, Pa.

H-O-H—Compounds, water treatment. Haering & Co., Inc., D. W., Chicago, Ill.

Hager—Valves. Williams Gauge Co., Pittsburgh, Pa.

Hairbestos—Insulation. Wilson & Co., Chicago, Ill.

Hancock—Valves. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.

Handy — Valves. Lunkenheimer Co., Cincinnati, O.

Handy Andy—Vise stands. Western Wire Products Co., St. Louis, Mo.

Handy Flux—Solder. Handy & Harman, New York, N. Y.

Hanite Metallo — Packing. Metallo Gasket Co., New Brunswick, N. J.

Hardweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Haveg—Pipe, tanks. Continental Diamond Fibre Co., Newark, Del.

Hawks—Burners, humidifiers. Hugo Mfg. Co., West Duluth, Minn.

Heat Fan—Unit heaters. Air Devices Corp., Chicago, Ill.

Heavy Duty—Furnaces. International Heater Co., Utica, N. Y.

Helical—Tubing. Rome-Turney Radiator Co., Rome, N. Y.

Hensel—Welders. Maple Valley Mfg. Co., Mapleton, Ia.

Herculoy—Sheets, tubing, welding rod. Revere Copper & Brass, Inc., New York, N. Y.

Hevikoat—Electrodes. Universal Power Corp., Cleveland, O.

Highflex—Belting. Goodrich Co., B. F., Akron, O.

Hilger—Coils, refrigerating compressors, unit coolers, dehumidifiers, cooling towers, unit air conditioners. XL Refrigerating Co., Inc., Chicago, Ill.

Hi-Lo—Pumps. Yeomans Bros. Co., Chicago, Ill.

Hi-Spra — Spray nozzles. Schubert-Christy Corp., St. Louis, Mo.

Hitchings—Boilers. Burnham Boiler Corp., Irvington, N. Y.

Hi-Test—Pipe. Walworth Co., New York, N. Y.

Hitoncast—Grilles, registers. Tuttle & Bailey, Inc., New Britain, Conn.

Hoffman-Economy — Pumps. Hoffman Specialty Co., Inc., Waterbury, Conn.

Holdfast—Solder. American Brass Co., Waterbury, Conn.

Hold-Heet—Air filters, unit heaters, humidifiers, humidistats, ozone apparatus, relays, heating surface, thermostats, unit air conditioners, regulators, unit air humidifiers, valves. Russell Electric Co., Chicago, Ill.

Holt—Strainers. Rosedale Foundry & Machine Co., Pittsburgh, Pa.

Horton—Tanks. Chicago Bridge & Iron Wks., Chicago, Ill.

Hovalco — Valves. Homestead Valve Mfg. Co., Coraopolis, Pa.

Huber—Stokers. Flynn & Emrich Co., Baltimore, Md.

Humidiguide—Hygrometers. Taylor Instrument Companies, Rochester, N. Y.

Humidostat — Humidistats. Johnson Service Co., Milwaukee, Wis.

Humi-Temps—Unit air coolers. Larkin Refrigerating Corp., Atlanta, Ga.

Humitherm—Unit air conditioners, unit air humidifiers. Grinnell Co., Inc., Providence, R. I.

Humitrol—Hygrometers. Lewis Air Conditioners, Inc., Minneapolis, Minnesota.

Humphrey—Unit heaters. General Gas Light Co., Kalamazoo, Mich.

Hycarb—Electrodes. Universal Power Corp., Cleveland, O.

Hydramotor—Valves. General Controls Co., San Francisco, Cal.

Hydro—Recorders. Bacharach Industrial Instrument Co., Pittsburgh, Pa.

Hydro—Valves. Kieley & Mueller, Inc., New York, N. Y.

Hydrolator—Circulators. Janette Mfg. Co., Chicago, Ill.

Hydrozone—Ionization and ozone apparatus, water treatment. American Hydrozone Co., Inc., New York, N. Y.

Hy-Duty — Fans. Schwitzer-Cummins Co., Indianapolis, Ind.

Hylo—Heating systems. Webster & Co., Warren, Camden, N. J.

Hy-Test—Water heaters. Smith Co., H. B., Westfield, Mass.

I

I-R—Ingersoll-Rand, New York, N. Y.

Ice-O-Matic—Refrigerating compressors. Williams Oil-O-Matic Heating Corp., Bloomington, Ill.

Ideal—Boilers, water heaters, valves. American Radiator Co., New York, N. Y.

Ideal—Ventilators. Tuttle & Bailey, Inc., New Britain, Conn.

Impact—Spray nozzles. Cooling Tower Co., Inc., New York, N. Y.

Imperial—Boilers. National Radiator Corp., Johnstown, Pa.

In-Cel-Wood—Insulation. Cornell Wood Products Co., Chicago, Ill.

IngAclad—Stainless clad sheets. Ingersoll Steel & Disc Co., Chicago, Ill.

Insertion Thermostat — Thermostats. Johnson Service Co., Milwaukee, Wis.

Instant—Heaters, preheaters. Johnson Corp., Three Rivers, Mich.

Instant—Water heaters. Sterling Engineering Co., Milwaukee, Wis.

Insulfil—Insulation. Refractory & Insulation Corp., New York, N. Y.

Ironton—Burners. Continental Stove Corp., Ironton, O.

J

J—Fittings, flanges, unions. Jenkins Mfg. Co., New York, N. Y.

J-M—Traps. D. G. C. Trap & Valve Co., Inc., New York, N. Y.

J. M. C.—Burners. Johnson Mfg. Co., Waterloo, Ia.

Jacknife—Hygrometers, psychrometers. A. C. E., Inc., Chicago, Ill.

Janitrol—Burners, furnaces, heaters, unit air conditioners, unit air humidifiers. Surface Combustion Corp., Toledo O.

Jarco—Unions. Jarecki Mfg. Co., Erie, Pa.

Jennings—Pumps, ejectors. Nash Engineering Co., South Norwalk, Conn.

Jointite—Insulation. Mundet Cork Corp., New York, N. Y.

Jones—Stokers. Riley Stoker Corp., Worcester, Mass.

K

K—Fittings. Kuhns Brothers Co., Dayton, O.

Kable Kord—Belting. L. H. Gilmer Co., Philadelphia, Pa.

Kamanco—Water heaters. Mears-Kane-Ofeldt Inc., Philadelphia, Pa.

Kane—Boilers, gas burners. Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.

Kathabar—Dehumidifiers, unit air conditioners. Surface Combustion Corp., Toledo, O.

Kelly—Valves. National Metal Products Corp., Chicago, Ill.

Kentucky—Sheets. Newport Rolling Mill Co., Newport, Ky.

Key Graphite Paste—Cement and compounds. Key Boiler Equipment Co., East St. Louis, Ill.

Key-Tite—Cement and compounds. Key Boiler Equipment Co., East St. Louis, Ill.

Kidskin—Packing. Darcoid Co., Inc., New York N. Y.

King-clip—Valves. Lunkenheimer Co., Cincinnati, O.

Klinger—Valves. Klingerit, Inc., New York, N. Y.

K-Master—Strainers, traps. Kaye & Macdonald, Inc., West Orange, N. J.

Kompak—Air filters. Independent Air Filter Co., Chicago, Ill.

Kooler-Aire—Air washers. U. S. Air Conditioning Corp., Minnapolis, Minn.

Kramer—Condensers, heaters, radiation, surface, tubing. Trenton Auto Radiator Wks., Trenton, N. J.

Kromax — Packing. Watson-Stillman Co., Roselle, N. J.

Kroy—Unit heaters. Carrier Engineering Corp., Newark, N. J.

Kwic-Lift—Hangers or brackets. Sterling Engineering Co., Milwaukee, Wis.

L

L. A.—Motors. Louis Allis Co., Milwaukee, Wis.

L&N—Regulators. Leeds & Northrup Co., Philadelphia, Pa.

L-R—Couplings. Lovejoy Tool Works, Chicago, Ill.

L. R. D.—Valves. Grinnell Co., Inc., Providence, R. I.

Laddi—Heaters. Johnson Co., S. T. Oakland, Cal.

Lansdale—Heaters. Central Radiator Co., New York, N. Y.

Lasten—Water heaters, Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.

Lavigne—Valves. Commonwealth Brass Corp., Detroit, Mich.

Lawson—Wrenches. U. S. Hame Co., Buffalo, N. Y.

Leader—Boilers, burners. Pressure Oil Burners, Inc., York, Pa.

Lectrodryer—Dehumidifiers, unit air conditioners. Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.

Levelometer — Gages. Liquidometer Corp., Long Island City N. Y.

Limpet—Insulation. Keasbey & Mattison Co., Ambler, Pa.

Linc-Weld—Motors. Lincoln Electric Co., Cleveland, O.

Linofelt—Insulation. Union Fibre Co., Winona, Minn.

Lipman—Compressors, heat exchangers, cooling surface, unit air conditioners. General Refrigeration Sales Co., Beloit, Wis.

Little Giant—Switches. Tork Clock Co., Inc., Mt. Vernon, N. Y.

Lo-Blast—Burners. National Machine Wks., Chicago, Ill.

Locarb—Electrodes. Universal Power Corp., Cleveland, O.

Lock Ring Seal—Packing. Williams Gauge Co., Pittsburgh, Pa.

Logan—Radiation. Logansport Radiator Equipment Co., Logansport, Ind.

Lord Burnham—Boilers. Burnham Boiler Corp., Irvington, N. Y.

Lubricore—Packing. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Luminarc—Electrodes. Universal Power Corp., Cleveland, O.

Lyonore—Sheets. Lyon, Conklin & Co., Inc., Baltimore, Md.

M

M & E—Refrigerating compressors. Merchant & Evans Co., Philadelphia, Pa.

M & M—Feeders, switches, valves. McDonnell & Miller, Chicago, Ill.

MIF—Clamps, couplings, fittings. Malleable Iron Fittings Co., Branford, Conn.

MJL—Manometers, meters, recorders. Morey & Jones, Ltd., Los Angeles, Cal.

MKO—Boiler feeders. Mears-Kane-Ofeldt, Inc., Philadelphia ,Pa.

Macheta—Fans. Aerovent Fan Co., Piqua, O.

Magic—Boilers. Joliet Heating Corp., Joliet, Ill.

Magicaire—Unit heaters. Schoedinger, F. O., Columbus, O.

Magic-Weather—Air washers, fans, unit air coolers. Scott Ballantyne Co., Omaha, Nebr.

Majestic—Boilers. Ames Iron Wks., Div. of Pierce Butler Radiator Corp., Oswego, N. Y.

Manganweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Martel — Cooling towers. Schubert-Christy Corp., St. Louis, Mo.

Martell—Packing. France Packing Co., Tacony, Philadelphia, Pa.

Massachusetts — Fans, Unit heaters, blower wheels, air washers. Bishop & Babcock Sales Co., Cleveland, O.

Master—Thermostats. White Mfg. Co., St. Paul, Minn.

Master—Unions. Lockport Fittings Co., Inc., Lockport, N. Y.

Mayflower—Refrigerating compressors, cooling surface, unit air coolers. Hardy Mfg. Co., Inc., Dayton, O.

McDaniel—Eliminators, floats, traps. Watson & McDaniel Co., Philadelphia, Pa.

McKee—Blowers, boilers, burners, feeders, pumps, regulators, tanks, torches, valves. Eclipse Fuel Engineering Co., Rockford, Ill.

McKnight—Registers. Tuttle & Bailey, Inc., New Britain, Conn.

Mechanovent—Ventilators. New York Blower Co., Chicago, Ill.

Menlo—Water heaters. Smith Co., H. B., Westfield, Mass.

Merkustat — Regulators, switches. Marsh Corp., Jas. P., Chicago, Ill.

Micromax—Psychrometers, recorders, recorder-controllers, thermometers. Leeds & Northrup Co., Philadelphia, Pa.

Midas—Welders. Commonwealth Mfg. Corp., Cincinnati, O.

Midget — Radiation. Utica Radiator Corp., Utica, N. Y.

Mills—Boilers. Smith Co., H. B., Westfield, Mass.

Milvaco — Air eliminators, feeders, strainers, traps, unions, valves. Milwaukee Valve Co., Milwaukee, Wis.

Milwaukee—Heaters. Blower Application Co., Milwaukee, Wis.

Milwaukee—Window ventilator and filter units. Perfex Radiator Co., Milwaukee, Wis.

Milwaukee Automatic—Stokers. Automatic Stoker Corp., Milwaukee, Wis.

Minfelt—Cement, pipe covering. Mineral Felt Co., Toledo, O.

MKayO—Boilers. Mears - Kane - Ofeldt, Inc., Philadelphia, Pa.

Mobilaire—Unit air coolers. Westinghouse Electric & Mfg. Co., Mansfield, O.

Moderator—Heating system. Warren Webster Co., Camden, N. J.

Modulation—Valves. Webster & Co., Warren, Camden, N. J.

Modutrol—Heating systems. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Mohawk—Pipe. Cohoes Rolling Mill Co., Cohoes, N. Y.

Monarch—Furnaces. Forest City Foundries Co., Cleveland, O.

Moncrief—Furnaces, sheet metal pipe and fittings. Henry Furnace & Foundry Co., Cleveland, O.

Mono-Cast—Pipe. American Cast Iron Pipe Co., Birmingham, Ala.

Monoloy—Pipe. American Cast Iron Pipe Co., Birmingham, Ala.

Moore—Hangers, brackets, inserts. Carty & Moore Engineering Co., Detroit, Mich.

Morflex — Flexible couplings. Morse Chain Co., Ithaca, N. Y.

Mortex—Cement, insulation. Mortell Co., J. W., Chicago, Ill.

Mosher—Separators. Barrett Machine Co., N. S., Pittsburgh, Pa.

Motoco—Recorders, thermometers, Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., La Crosse, Wis.

Motopump—Pumps. Yeomans Bros. Co., Chicago, Ill.

Multiflex—Valves. Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Multi-Panel—Air filters. American Air Filter Co., Inc., Louisville, Ky.

Multiseal—Gaskets. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Multi-V—V Belts. Goodrich Co., B. F., Akron, O.

Multivane—Fans and blowers. B. F. Sturtevant Co., Boston, Mass.

Murray—Radiation. American Radiator Co., New York, N. Y.

N

N-M-D—Valves. Lunkenheimer Co., Cincinnati, O.

Nash Hytor—Pumps. Nash Engineering Co., South Norwalk, Conn.

National—Compressors. Janette Mfg. Co., Chicago, Ill.

National—Pumps. Austin-Mason Co., New York, N. Y.

National-Shelby—Tubing. National Tube Co., Pittsburgh Pa.

Naturzone—Insulation. Wilson & Co., Chicago, Ill.

Nemo—Insulating cement. Smith & Kanzler, Inc., Elizabeth, N. J.

New Cyclone—Dust collectors. Kirk & Blum Mfg. Co., Cincinnati, O.

New Kathode — Electrodes. Lincoln Electric Co., Cleveland, O.

New Lightweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Newport—Humidistats. Johnson Tool Co., East Providence, R. I.

New Standard—Traps. Kieley & Mueller, Inc., New York, N. Y.

Niagara—Furnaces. Forest City Foundries Co., Cleveland, O.

Niagara — Meters, strainers. Buffalo Meter Co., Buffalo, N. Y.

Ni-Resist—Pipe. Walworth Co., New York, N. Y.

Non-clog—Sewage ejectors. Chicago Pump Co., Chicago, Ill.

Norblo—Dust collectors, fans, filters, washers. Northern Blower Co., Cleveland, O.

Nordstrom—Valves. Merco-Nordstrom Valve Co., Pittsburgh, Pa.

Northern Breeze—Unit air coolers. Chicago Pump Co., Chicago, Ill.

Norwestco—Cement and compounds, boiler and radiator sealing compounds. Northwestern Chemical Co., Marietta, O.

Novoid—Insulation. Cork Import Corp., New York, N. Y.

Novus — Boilers. National Radiator Corp., Johnstown, Pa.

Nu-Air—Fans. Meier Electric & Machine Co., Indianapolis, Ind.

Nu-Notch — Mushroom ventilators. Knowles Mushroom Ventilator Co., New York, N. Y.

O

OB—Valves. Ohio Brass Co., Mansfield, O.

OK—Motors. Marathon Electric Mfg. Corp., Wausau, Wis.

Oblong—Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.

OCECO—Pumps. Johnston & Jennings Co., Cleveland, O.

Ofeldt—Boilers, regulators. Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.

Oil-O-Matic—Oil burners. Williams Oil-O-Matic Heating Corp., Bloomington, Ill.

Ol' Faithful — Unit air humidifiers. Maid-O-Mist, Inc., Chicago, Ill.

1, 2, 3 (Boiler treatment)—Boiler cleaning compounds. Dole Valve Co., Chicago, Ill.

Ortho-Clime — Unit air conditioners. Fairbanks, Morse & Co., Chicago, Ill.

Oxford—Unions. Standard Union Co., New York, N. Y.

Oxweld—Welding rod, welding and cutting apparatus. Linde Air Products Co., New York, N. Y.

P

PDQC — Pipe machines. Bignall & Keeler Machine Wks., Edwardsville, Ill.

P & H—Motors. Harnischfeger Corp., Milwaukee, Wis.

P & H—Hansen—Arc Welders. Harnischfeger Corp., Milwaukee, Wis.

Pacific—Boilers. United States Radiator Corp., Detroit, Mich.

Paintgrip — Sheets. American Rolling Mill Co., Middletown, O.

Palco—Packing. Greene, Tweed & Co., Co., New York, N. Y.

Palco Bark—Insulation. Pacific Lumber Co., San Francisco, Cal.

Palmetto—Packing. Greene, Tweed & Co., New York, N. Y.

Paracoil—Heaters, heat exchangers, preheaters. Davis Engineering Corp., Elizabeth, N. J.

Parko—Psychrometers. Parks-Cramer Co., Fitchburg, Mass.

Paxtite — Packing. Watson-Stillman Co., Roselle, N. J.

Pebble—Registers. Auer Register Co., Cleveland, O.

Peerless—Dust collectors, humidifiers, air washers. New York Blower Co., Chicago, Ill.

Peerless—Pipe machines. Bignall & Keeler Machine Works, Edwardsville, Ill.

Penn-M-Co—Fittings. Penn Mfg. Corp. of Washington, Pa., Washington, Pa.

Perfection—Plates. Beaton & Cadwell Mfg. Co., New Britain, Conn.

Perfection—Regulators, valves. American District Steam Co., North Tonawanda, N. Y.

Permopad — Air filters. Independent Air Filter Co., Chicago, Ill.

Petro—Oil burners. Petroleum Heat & Power Co., Stamford, Conn.

Pfening—Humidifiers, unit air conditioners, valves. Columbus Humidifier Co., Columbus, O.

Pipemaster—Wrenches. Erie Tool Wks., Erie, Pa.

Planoidal—Fans. Russell Electric Co., Chicago, Ill.

Plastiseal — Cement and compounds. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Playford—Stokers. Rosedale Foundry & Machine Co., Pittsburgh, Pa.

Plexifin—Unit heaters. Bayley Blower Co., Milwaukee, Wis.

Plexiform—Fans. Bayley Blower Co., Milwaukee, Wis.

Plumrite—Pipe. Bridgeport Brass Co., Bridgeport, Conn.

Plymco—Air filters. Plymouth Cordage Co., N. Plymouth, Mass.

Poly-Stage—Air filters. Burt Air Filter Corp., New York, N. Y.

Pottstown—Pumps. Martocello & Co., Jos. A., Philadelphia, Pa.

Power—Belting. Rhoads & Sons., J. E., Wilmington, Del.

Premier—Boilers. Combustion Engineering Co., Inc., New York, N. Y.

Premier — Boilers, heaters. National Radiator Corp., Johnstown, Pa.

Premier — Welding rod, electrodes. American Steel & Wire Co., Chicago, Ill.

Presstico—Insulation. Presstite Engineering Co., St. Louis, Mo.

Prest-O-Lite—Leak detectors, torches. Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.

Prest-O-Weld—Welding and cutting apparatus. Linde Air Products Co., New York, N. Y.

Probestos—Gaskets. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Protectomotor — Air filters. Staynew Filter Corp., Rochester, N. Y.

Protectorelay — Relays. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Protectovent—Window ventilator and filter units. Staynew Filter Corp., Rochester, N. Y.

Pulverzone—Stokers. American Coal Burner Co., Chicago, Ill.

Punkah—Louvers and shutters. White Co., Kelvin & Wilfred B., Boston, Mass.

Purox—Welding rod, solder, welding and cutting apparatus. Linde Air Products Co., Unit of Union Carbide & Carbon Corp., New York, N. Y.

Pyrex—Glass pipe. Corning Glass Wks., Corning, N. Y.

Pyro—Thermometers. Pyrometer Instrument Co., New York, N. Y.

Pyrofelt—Covering. Mineral Felt Co., Toledo, O.

Q

Q. F. R.—Pipe, tubing. Wheatland Tube Co., Philadelphia, Pa.

Quasi-Arc — Electrodes, welding rod. Keasbey & Mattison Co., Ambler, Pa.

Quilt—Insulation. Cabot, Inc., Samuel, Boston, Mass.

Quintuplet—Regulators. Maid-O-Mist, Inc., Chicago, Ill.

R

R & G—Grilles, registers. Register & Grille Mfg. Co., Brooklyn, N. Y.

R-K — Regulators. Ruggles-Klingeman Mfg. Co., Salem, Mass.

R. P & C.—Valves. Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.

Radi-Ion—Ionization apparatus, ozone apparatus. Montgomery Bros., San Francisco, Cal.

Rainbow—Humidifiers. Sheer Co., H. M., Quincy, Ill.

Rainbow Mist—Nozzles. Peterson Freezem Mfg. Co., Kansas City, Mo.

Raydiant—Radiation. Weil-McLain Co., Chicago, Ill.

Record-O-Stat — Recorder - Controllers. Johnson Service Co., Milwaukee, Wis.

Red Band—Motors. Howell Electric Motors Co., Howell, Mich.

Red Diamond — Conduit, covering. American District Steam Co., North Tonawanda, N. Y.

Red Dome—Heaters. Smith Co., H. B., Westfield, Mass.

Red E. Haul—Pipe machines. American Die & Tool Co., Reading, Pa.

Red E. Quick—Pipe machines. American Die & Tool Co., Reading, Pa.

Red Flash—Traps. Ellis Drier Co., Chicago, Ill.

Red Head—Tongs. Billings & Spencer Co., Hartford, Conn.

Red Head—Traps. Ellis Drier Co., Chicago, Ill.

Redsquare — Boilers. Utica Radiator Corp., Utica, N. Y.

Red Top — Humidistats, thermostats. H-B Instrument Co., Philadelphia, Pa.

Reed-Jenkins — Valves. Reed Steam Equipment Co., Bridgeport, Conn.

Reed-Warren—Pumps. Reed Steam Equipment Co., Bridgeport, Conn.

Relay—Filters. Ripley Co., W. R., Tacoma, Wash.

Reliance—Regulators. General Controls Co., San Francisco, Cal.

Remco—Bases. Manley Products Corp., York, Pa.

Remote Re-Adjustable — Thermostats. Johnson Service Co. Milwaukee, Wis.

Renewo—Valves. Lunkenheimer Co. Cincinnati, O.

Renu-Vent—Air filters. American Air Filter Co., Inc., Louisville, Ky.

Rex—Cement. Keasbey Co., Robert A., New York, N. Y.

Rex-AC—Pillow Blocks, fans. Air Controls, Inc., Cleveland, O.

Rex-Airate—Roof Ventilators, blower wheels. Air Controls, Inc., Cleveland, O.

Rexoil—Boilers, burners, furnaces, heaters. Reif-Rexoil, Inc., Buffalo, N. Y.

Rexvane—Fans, unit heaters. Sturtevant Co., B. F., Boston, Mass.

Richvar—Boilers, radiation. Richmond Radiator Co., Inc., Uniontown, Pa.

Ridgid—Pipe machines, wrenches, cutters, vises. Ridge Tool Co., Elyria, O.

Rifco—Unions. Rhode Island Fittings Co., Hillsgrove, R. I.

Rihco—Humidifiers. Rhode Island Humidifier & Ventilating Co., Boston, Mass.

Rockaway—Regulators, valves. Kieley & Mueller, Inc., New York, N. Y.

Rocktex—Insulation. Carey Co., Philip, Lockland, Cincinnati, O.

Rocop—Heaters. Rome-Turney Radiator Co., Rome, N. Y.

Roofvane—Ventilators. Sturtevant Co., B. F., Boston, Mass.

Roof-Vent — Ventilators. Reed Unit-Fans, Inc., New Orleans, La.

Root—Fittings, pipe. Abendroth & Root Mfg. Co., Newburgh, N. Y.

Ross-Harrison — Heaters. Ross Engineering Corp., J. O., New York, N. Y.

Rotameter—Flow meters. Schutte & Koerting Co., Philadelphia, Pa.

Roto Blast—Furnaces. Moncrief Furnace Co., Atlanta, Ga.

Roto-Clone—Dust collectors. American Air Filter Co., Inc., Louisville, Ky.

Rotojet—Spray nozzles. Binks Mfg. Co., Chicago, Ill.

Royal—Boilers, furnaces, water heaters. Hart & Crouse Co., Inc., Utica, N. Y.

Royal "Oriole" — Radiation. Hart & Crouse Co., Inc., Utica, N. Y.

Ruberoid - Watson — Cement, covering. Ruberoid Co., New York, N. Y.

Rubyfluid—Solder. Ruby Chemical Co., Columbus, O.

Runwell—Packing. Greene, Tweed & Co., New York, N. Y.

Ryan—Burners, valves. R-S Products Corp., Philadelphia, Pa.

S

SF—Welding rod, welding and cutting apparatus. Sight Feed Generator Co., Richmond, Ind.

S & P—Burners, governors, preheaters, regulators, strainers, valves. Staples & Pfeiffer, Ltd., San Francisco, Cal.

St. John—Condensation meters. American District Steam Co., North Tonawanda, N. Y.

Sal-Mo — Cement, covering, insulation, packing, pipe. Sall Mountain Co., Chicago, Ill.

Saunders—Pipe cutters. Erie Tool Works, Erie, Pa.

Scobronze—Welding rod. Scovill Mfg. Co., Waterbury, Conn.

Scru-peller—Ejectors. Chicago Pump Co., Chicago, Ill.

Seismo-Dampers—Bases. Korfund Co., Long Island City, N. Y.

Selfvulc—Cement, covering, insulation. Self-Vulcanizing Rubber Co., Inc., Chicago, Ill.

Sensitrol—Relays. Weston Electrical Instrument Corp., Newark, N. J.

Series 3—Heaters. Fedders Mfg. Co., Inc., Buffalo, N. Y.

Sesure—Gages. Yarnall-Waring Co., Philadelphia, Pa.

Shawco—Bends, joints, headers. Shaw Co., Benjamin F., Wilmington, Del.

Shield-Arc — Electrodes, arc welders. Lincoln Electric Co., Cleveland, O.

Shield Arc Eighty Five — Electrodes. Lincoln Electric Co., Cleveland, O.

Shield Arc One Hundred—Electrodes. Lincoln Electric Co., Cleveland, O.

Silcrome—Sheets. Ludlum Steel Co., Watervliet, N. Y.

Silentaire — Window ventilator units. Truscon Steel Co., Youngstown, O.

Silent Floating—Bases. Buffalo Forge Co., Buffalo, N. Y.

Silentile—Insulation. Mineral Felt Co., Toledo, O.

Silentvane—Fans. Sturtevant Co., B. F., Boston, Mass.

Sil-Fos — Solder. Handy & Harman, New York, N. Y.

Silowatt—Valves. Electrimatic Corp., Chicago, Ill.

Silverlink—Chain drives. Link-Belt Co., Chicago, Ill.

Silverseal—Packing. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Silverstreak — Chain drive. Link-Belt Co., Chicago, Ill.

Silvertop—Traps. V. D. Anderson Co., Cleveland, O.

Sirocco—Blowers, dust collectors, fans, grilles, unit air conditioners, unit air coolers, unit air humidifiers, air washers. American Blower Corp., Detroit, Mich.

Slaset—Valves. Lukenheimer Co., Cincinnati, O.

Smoot—Regulators. Republic Flow Meters Co., Chicago, Ill.

Sodrin—Boiler and radiator sealing compound. Dole Valve Co., Chicago, Ill.

Sovereign—Packing. Darcoid Co., Inc., New York, N. Y.

Special '98—Regulators, valves. Kieley & Mueller, Inc., New York, N. Y.

Speedarc—Electrodes. Universal Power Corp., Cleveland, O.

Speed Heater—Unit heaters. Sturtevant Co., B. F., Boston, Mass.

Spider Web—Air filters. Wilson & Co., Chicago, Ill.

Spirodome—Spray nozzles. Cooling Tower Co., Inc., New York, N. Y.

Sporlan—Valves. Spoehrer-Lange Co., St. Louis, Mo.

Spraco—Nozzles, separators, strainers, washers. Spray Engineering Co., Somerville, Mass.

Spra-Rite—Nozzles. Binks Mfg. Co., Chicago, Ill.

Stabilflo—Valves. Foxboro Co., Foxboro, Mass.

Stable-Arc — Electrodes, arc welders. Lincoln Electric Co., Cleveland, O.

Stainarc—Electrodes. Universal Power Corp., Cleveland, O.

Stainless—Cement and compounds. Grinnell Co., Inc., Providence, R. I.

Stainweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Stainweld A—Electrodes. Lincoln Electric Co., Cleveland, O.

Stainweld B—Electrodes. Lincoln Electric Co., Cleveland, O.

Standard—Traps. Kieley & Mueller, Inc., New York, N. Y.

Star—Ventilators. Merchant & Evans Co., Philadelphia, Pa.

Sterlco—Circulators, eliminators, floats, gages, pumps, strainers, heating systems, traps, valves. Sterling Engineering Co., Milwaukee, Wis.

Stictite—Cement. Refractory & Insulation Corp., New York, N. Y.

Stillson — Pipe wrenches. Erie Tool Wks., Erie, Pa.

Stoker-King — Stokers. Stokers, Inc., Detroit, Mich.

Stokol—Stokers. Schwitzer - Cummins Co., Indianapolis, Ind.

Stowe—Stokers. Johnston & Jennings Co., Cleveland, O.

Strait-Line — Bases. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Streamaire—Unit heaters, radiation, cooling surface. Young Radiator Co., Racine, Wis.

Streamline—Registers. Tuttle & Bailey, Inc., New Britain, Conn.

Stronghold—Belting. Rhoads & Sons, J. E., Wilmington, Del.

Sullarc — Electrodes. Universal Power Corp., Cleveland, O.

Summer-Winter—Thermostats. Johnson Service Co., Milwaukee, Wis.

Superadjustable — Wrenches. Williams & Co., J. H., New York, N. Y.

Super Cold Fin — Cooling surface. Rempe Coil Co., Chicago, Ill.

Super-deLavaud—Pipe. U. S. Pipe & Foundry Co., Burlington, N. J.

Superector—Wrenches. Williams & Co., J. H., New York, N. Y.

Super-S—Gages. Klingerit, Inc., New York, N. Y.

Super Silvertop—Traps. V. D. Anderson Co., Cleveland, O.

Super-type—Unit heaters. Autovent Fan & Blower Co., Chicago, Ill.

Sure Seal—Cement and compounds. Grinnell Co., Inc., Providence, R. I.

Surevent—Valves. Gorton Heating Corp., Cranford, N. J.

Surlock—Registers. Tuttle & Bailey, Inc., New Britain, Conn.

Sylphon—Traps. Webster & Co., Warren, Camden, N., J.

Synchrotax — Thermostats. Foxboro Co., Foxboro, Mass.

Syncretizer—Unit ventilators. Nesbitt, Inc., John J. & Buckeye Blower Co., Philadelphia, Pa.

T

TE—Compressors. Janette Mfg. Co., Chicago, Ill.

Tabasco — Water heaters. Kewanee Boiler Corp., Kewanee, Ill.

Tag—Humidistats, hygrometers, manometers, meters, psychrometers, recorders, regulators, thermometers, traps, valves. Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.

Tank-O-Meter—Gages. Uehling Instrument Co., Paterson, N. J.

Tannate—Belting, packing. Rhoads & Sons, J. E., Wilmington, Del.

Tanseal — Packing. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Tatroweld—Welders. Tatro Bros., Inc., Decorah, Ia.

Teksag Colloid—Boiler compounds. American Teksag Products Co., Inc., Mount Vernon, N. Y.

Televisor—Gages. Schutte & Koerting Co., Philadelphia, Pa.

Teltru—Anemometers, gages. A. C. E., Inc., Teltru Division, Chicago, Ill.

Tem-Clock (Electric) — Time switches. Penn Electric Switch Co., Des Moines, Ia.

Temlok—Insulation. Armstrong Cork Products Co., Lancaster, Pa.

Texaco—Lubricating oil. Texas Co., New York, N. Y.

Texrope — V-belt drives. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Thermair—Furnaces, heaters. New York Blower Co., Chicago, Ill.

Thermaire — Heaters. Schoedinger, F. O., Columbus, O.

Thermofin — Radiation. Grinnell Co., Inc., Providence, R. I.

Thermoflex — Strainers, heating systems, traps, valves. Cashin Co., W. D., Boston, Mass.

Thermoguide — Thermometers. Taylor Instrument Companies, Rochester, N. Y.

Thermolier — Unit heaters, unit air coolers. Grinnell Co., Inc., Providence, R. I.

Therm-o-tile—Conduit. Porter & Co., Inc., H. W., Newark, N. J.

Thermotrol—Valves. Sterling Engineering Co., Milwaukee, Wis.

Thermovent—Unit ventilators. Nesbitt, Inc., John J., & Buckeye Blower Co., Philadelphia, Pa.

Thredolets—Fittings. Bonney Forge & Tool Wks., Allentown, Pa.

Three Point—Valves. Webster & Co., Warren, Camden, N. J.

Thrift—Water heaters. Surface Combustion Corp., Toledo, O.

Throway—Air filters. American Air Filter Co., Inc., Louisville, Ky.

Ticone—Boilers. Titusville Iron Wks. Co., Titusville, Pa.

Tighton—Unions. Standard Union Co., New York, N. Y.

Timetrol (Manual) — Time switches. Penn Electric Switch Co., Des Moines, Ia.

Tiscot—Boilers. Titusville Iron Wks. Co., Titusville, Pa.

Tobin Bronze—Welding rod. American Brass Co., Waterbury, Conn.

Toncan—Pipe, sheets, tubing. Republic Steel Corp., Cleveland, O.

Toncanarc — Electrodes. Universal Power Corp., Cleveland, O.

Transite—Pipe. Johns-Manville, New York, N. Y.

Transitorq—Speed reducers. New Departure Div., General Motors Corp., Bristol, Conn.

Trem-Bar—Insulation. United States Gypsum Co., Chicago, Ill.

Trimo—Cutters, vises, wrenches. Trimont Mfg. Co., Boston, Mass.

Triple Duty—Boilers. Bass Foundry & Machine Co., Ft. Wayne, Ind.

Tri-Sli—Dampers, registers. Tuttle & Bailey, Inc., New Britain, Conn.

Tritrol — Regulators, switches. Marsh Corp., Jas. P., Chicago, Ill.

Tritrol—Heating systems. Marsh Tritrol Co., Chicago, Ill.

Triumph—Gaskets. Goetze Gasket & Packing Co., Inc., New Brunswick, N. J.

Triumph—Pipe line filters. Adams Co., R. P., Buffalo, N. Y.

Trojan—Boilers. Burnham Boiler Corp., Irvington, N. Y.

Truflex—Bi-metals. General Plate Co., Attleboro, Mass.

Try-Me—Regulators, strainers, valves. Tryco Products, Inc., Westfield, Mass.

Tubejet—Pumps. Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Turbo—Air washers, dehumidifiers, spray nozzles. Bayley Blower Co., Milwaukee, Wis.

Turbo-Aquatherm — Water heaters. Dahlquist Mfg. Co., Inc., Boston, Mass.

Turbo Vane—Fans and blowers. B. F. Sturtevant Co., Boston, Mass.

Turret—Pumps. Yeomans Bros. Co., Chicago, Ill.

20th Century—Bearings. Roller Bearing Co. of America, Trenton, N. J.

Tymit—Switches. Tork Clock Co., Inc., Mt. Vernon, N. Y.

U

UAC—Unit air conditioners. Burnham Boiler Corp., Irvington, N. Y.

U. F. S.—Clamps. Grinnell Co., Inc., Providence, R. I.

USS—Pipe, tubing. National Tube Co., Pittsburgh, Pa.

U-Loy—Sheets. Republic Steel Corp., Cleveland, O.

Uniblade—Fans. Autovent Fan & Blower Co., Chicago, Ill.

Unicool—Humidifiers, unit air conditioners, unit air coolers, unit air humidifiers, air washers. Betz Unit Air Cooler Co., Kansas City, Mo.

Uni-flo—Grilles. Barber-Colman Co., Rockford, Ill.

Universal—Air filters. Hugo Mfg. Co., West Duluth, Minn.

Universal—Hygrometers, psychrometers. A. C. E., Inc., Chicago, Ill.

Upson—Bolts. Republic Steel Corp., Cleveland, O.

Utica—Radiation. International Heater Co., Utica, N. Y.

V

Vacu-Draft — Blowers. Muncie Gear Wks., Inc., Muncie, Ind.

Vaughan—Meters. Spray Engineering Co., Somerville, Mass.

Vento — Heating surface. American Radiator Co., New York, N. Y.

Vent-Rite—Air valves. Anderson Products, Inc., Cambridge, Mass.

Vent-Rite Balancer—Valves. Anderson Products, Inc., Cambridge, Mass.

Ventura—Fans. American Blower Corp., Detroit, Mich.

Venturaflo — Unit heaters. American Blower Corp., Detroit, Mich.

Vercel—Covering. Eagle-Picher Lead Co., Cincinnati, O.

Vibracork — Bases. Armstrong Cork Products Co., Lancaster, Pa.

Vibro-Dampers — Bases. Korfund Co., Long Island City, N. Y.

Vibro Insulators—Bases. Goodrich Co., B. F., Akron, O.

Victor—Welding and cutting apparatus. Sight Feed Generator Co., Richmond, Ind.

Victory — Burners. Caloroil Burner Corp., Hartford, Conn.

Vik-Air—Unit air conditioners. Viking Air Conditioning Corp., Cleveland, O.

Vital Ion—Ionization apparatus. Russell Electric Co., Chicago, Ill.

V-Meth-L — Refrigerant. Virginia Smelting Co., West Norfolk, Va.

Vulcalock—Fittings, pipe, valves. Goodrich Co., B. F., Akron, O.

Vulcan—Tongs, vises, wrenches. Williams & Co., J. H., New York, N. Y.

Vulcan—Unions. Rockwood Sprinkler Co. of Mass., Worcester, Mass.

Vulcan Boll-Weevil—Tongs, wrenches. Williams & Co., J. H., New York, N. Y.

Vulcan Superior — Tongs, vises, wrenches. Williams & Co., J. H., New York, N. Y.

Vulco—Drives. Gates Rubber Co., Denver, Col.

W

W&B—Wrenches. Williams & Co., J. H., New York, N. Y.

WEACO—Heaters. Warren Electric Appliance Co., Warren, Pa.

WHS—Blocks, couplings, drives, reducers. Smith, Inc., Winfield H., Springville, N. Y.

W J—Compounds. Radiator Specialty Co., Charlotte, N. C.

W. & Mc.D.—Valves. Watson & McDaniel Co., Philadelphia, Pa.

Walco—Wrenches. Walworth Co., New York, N. Y.

Walseal—Fittings, valves. Walworth Co., New York, N. Y.

Waltham—Burners. d'Este Co., Julian, Charlestown, Mass.

Warco—Gages, valves. Russell & Co., W. A., New York, N. Y.

Water-Boy—Feeders, unit air humidifiers. Maid-O-Mist, Inc., Chicago, Ill.

Waterfilm—Boilers. Koven & Bro., L. O., Jersey City, N. J.

Watson—Governors, regulators, valves. Watson & McDaniel Co., Philadelphia, Pa.

Way "Loctor"—Access panels. Walsh Spencer Co., Boston, Mass.

Wearweld—Electrodes. Lincoln Electric Co., Cleveland, O.

Weathermaker—Unit air conditioners. Carrier Engineering Corp., Newark, N. J.

Weatherwood—Insulation. United States Gypsum Co., Chicago, Ill.

Webster—Air washers, nozzles. Strandwitz & Co., Inc., Camden, N. J.

Weldells—Welding fittings. Taylor Forge & Pipe Works, Chicago, Ill.

Weldfast—Welding rod. Revere Copper & Brass, Inc., New York, N. Y.

Weldolets—Fittings. Bonney Forge & Tool Works, Allentown, Pa.

Westotherm — Thermometers. Weston Electrical Instrument Corp., Newark, N. J.

Weyher—Circulators. Automatic Stoker Corp., Milwaukee, Wis.

White — Circulators, valves. Hoosick Engineering Co., Inc., Hoosick Falls, N. Y.

Wilson—Arc welders. Air Reduction Sales Co., New York, N. Y.

Wind-O-Vent — Window ventilator and filter units. Reed Unit-Fans, Inc., New Orleans, La.

Winner—Registers. Auer Register Co., Cleveland, O.

Winter Chaser—Unit air humidifiers. Campbell Heating Co., Des Moines, Ia.

Wintermaster—Unit air humidifiers. International Boiler Works Co., East Stroudsburg, Pa.

Witch—Hangers, protectors. Carpenter & Paterson, Inc., East Boston, Mass.

Wonder—Benders. American Pipe Bending Machine Co., Inc., Boston, Mass.

X

Xit—Ventilators. Iona Ventilator Co., Inc., Philadelphia, Pa.

Y

Yager—Solder. Benson Co., Inc., Alex R., Hudson, N. Y.

Yarway — Expansion joints, nozzles, traps, valves. Yarnall-Waring Co., Philadelphia, Pa.

York-Lalor—Valves. York Oil Burner Co., Inc., York, Pa.

Z

Zephyr—Unit air conditioners. Savage Arms Corp., New York, N. Y.

Zerozone — Refrigerating compressors. Copeland Refrigeration Corp., Mt. Clemens, Mich.

DIRECTORY SECTION
HEATING, PIPING AND AIR CONDITIONING EQUIPMENT FOR INDUSTRY AND LARGE BUILDINGS
PART 4—MANUFACTURERS' ADDRESSES

A

Abendroth & Root Mfg. Co., Newburgh, N. Y.
Accurate Mfg. Works, 2432 Milwaukee Ave., Chicago, Ill.
A. C. E., Inc., Teltru Division, 179 W. Washington St., Chicago, Ill.
Ace Engineering Co., 1735 W. 31st St., Chicago, Ill.
Acer & Whedon, Medina, N. Y.
Acheson Mfg. Co., Braddock P. O., Rankin, Pa.
Acme Asbestos Covering & Flooring Co., 218 N. Elizabeth St., Chicago, Ill.
Acme Heating & Ventilating Co., Inc., 4224 Lowe Ave., Chicago, Ill.
Acme Industries, Inc., Cor. Calhoun & Ingham Sts., Jackson, Mich.
Acme Tin Plate & Roofing Supply Co., Philadelphia, Pa.
Acorn Refining Co., 8001 Franklin Ave., Cleveland, O.
Adams Co., J. D., 217 S. Belmont Ave., Indianapolis, Ind.
Adams Co., R. P., 220 Delaware Ave., Buffalo, N. Y.
Adams Engineering Co., 2607 S. Wentworth Ave., Chicago, Ill.
Adams Frank Electric Co., 3650 Windsor St., St. Louis, Mo.
Advanced Engineering Co., 2413 Aramingo Ave., Philadelphia, Pa.
Advance Fan & Blower Co., 3428 Bagley, Detroit, Mich.
Advanced Refrigerating Systems Co., 33rd and Arch Sts., Philadelphia, Pa.
Aeolus Dickinson Co., 3320 S. Artesian Ave., Chicago, Ill.
•Aerofin Corp., 850 Frelinghuysen Ave., Newark, N. J.
Aerovent Fan Co., 710 E. Ash St., Piqua, O.
Ahlberg Bearing Co., 317 E. 29th St., Chicago, Ill.
Air Controls, Inc., 1933 W. 114th St., Cleveland, O.
Aircraft Mfg. Co., 418 E. First St., Dayton, O.
Air Devices Corp., 64 E. 25th St., Chicago, Ill.
Airecon Industries, Inc., 2648 Botsford Ave., Detroit, Mich.
Airmaster Corp., 140 S. Dearborn St., Chicago, Ill.
•Air-Maze Corp., 812 Huron Rd., Cleveland, O.
Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y.
Airtemp, Inc., Leo St., Dayton, O.
•Airtherm Mfg. Co., 1474 S. Vandeventer Ave., St. Louis, Mo.
Ajax Flexible Coupling Co., Westfield, N. Y.
Akrat Ventilator Co., 1717 Carroll Ave., Chicago, Ill.
Akron Metallic Gasket Co., 155 N. Union, Akron, O.
Akwa Heaters, Inc., 101 Park Ave., New York, N. Y.
Alabama Pipe Co., Anniston, Ala.
Alco Products, Inc., 220 E. 42nd St., New York, N. Y.
•Alco Valve Co., Inc., 2628 Big Bend Blvd., St. Louis, Mo.
Alexander Bros., 406 N. 3rd, Philadelphia, Pa.
Alfol Insulation Co., Inc., Chrysler Bldg., New York, N. Y.
Allegheny Steel Co., Brackenridge, Pa.
Allen Billmyre Corp., 136 Water St., South Norwalk, Conn.
•Allen-Bradley Co., 1335 S. First St., Milwaukee, Wis.
Allen Corp., 9751 Erwin Ave., Detroit, Mich.
Allen-Sherman-Hoff Co., 225 S. 15th St., Philadelphia, Pa.
•Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Allis Co., Louis, 427 E. Stewart St., Milwaukee, Wis.
All Metal Weatherstrip Co., 229 W. Illinois St., Chicago, Ill.
Allpax Co., Inc., Mamaroneck, N. Y.
Allsteel Press Co., Inc., 12015 S. Peoria St., Chicago, Ill.
Alter-Arc Mfg. Co., 209 B St., Lawton, Okla.
Alton Mineral Wool Co., P. O. Box 268, Alton, Ill.
Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa.
•American Air Filter Co., Inc., 107 Central Ave., Louisville, Ky.
American Blower Corp., 6000 Russell St., Detroit, Mich.
•American Brass Co., 414 Meadow St., Waterbury, Conn.
American Car & Foundry Co., 30 Church St., New York, N. Y.
American Cast Iron Pipe Co., 2930 N. 16th St., Birmingham, Ala.
American Chain Co., Inc., Page Steel & Wire Div., 929 Connecticut Ave., Bridgeport, Conn.
American Coal Burner Co., 155 E. Superior St., Chicago, Ill.
American Coolair Corp., 3604 Mayflower St., Jacksonville, Fla.
American Cooling Tower Co., 2710 McGee St., Kansas City, Mo.
American Die & Tool Co., Buttonwood St., Reading, Pa.
•American District Steam Co., North Tonawanda, N. Y.
American Flange & Mfg. Co., Inc., Radio City, New York, N. Y.
American Flexible Coupling Co., 1401 German St., Erie, Pa.
American Foundry Equipment Co., 619 Byrkit St., Mishawaka, Ind.
American Foundry & Furnace Co., Washington St. at McClun, Bloomington, Ill.
•American Hair & Felt Co., 1820 Merchandise Mart, Chicago, Ill.
American Hard Rubber Co., 11 Mercer St., New York, N. Y.
American Hydrozone Co., Inc., 10 E. 40th St., New York, N. Y.
American Injector Co., 1481-14th St., Detroit, Mich.
American Instrument Co., Silver Springs, Ind.
American-Larson Ventilating Co., 1004 Keystone Bank Bldg., Pittsburgh, Pa.
American Manganese Bronze Co., Rhawn & Hegerman Sts., Philadelphia, Pa.
American Meter Co., Inc., 105 W. 40th St., New York, N. Y.
American Moistening Co., 260 W. Exchange St., Providence, R. I.
American Nickeloid Co., Box 127, Peru, Ill.
American Pipe Bending Machine Co., Inc., 37 Pearl St., Boston, Mass.
American Pipe Tool Co., 4533 W. Harrison St., Chicago, Ill.
American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.
•American Radiator Co., 40 W. 40th St., New York, N. Y.
•American Rolling Mill Co., 703 Curtis St., Middletown, O.
American Solder & Flux Co., Wayne Ave., and Berkley St., Philadelphia, Pa.
•American Steam Pump Co., 60 Capital Ave., N. E., Battle Creek, Mich.
American Steel & Wire Co., 208 S. La Salle St., Chicago, Ill.
American Teksag Products Co., Inc., 395 N. MacQuesten Pkwy., Mt. Vernon, N. Y.
American Thermometer Co., 2907 Clark Ave., St. Louis, Mo.
American Tube Works, 294 Washington St., Boston, Mass.
American Warming & Ventilating Co., 1017-1021 Summit St., Toledo, O.
American Well Wks., 100 N. Broadway, Aurora, Ill.
American Zinc Products Co., Greencastle, Ind.
Ames Co., W. R., 150 Hooper St., San Francisco, Cal.
Ames Iron Works, Division of Pierce Butler Radiator Corp., Oswego, N. Y.
Amirton Co., 49-53 E. 21st St., New York, N. Y.
Anchor Packing Co., 401 N. Broad St., Philadelphia, Pa.
Anchor Stove & Range Co., Third & Culbertson Sts., New Albany, Ind.
•Anderson Co., V. D., 1949 W. 96th St., Cleveland, O.
Anderson Products, Inc., 17 Tudor St., Cambridge, Mass.
Anderson Rotary Pump Co., 120 Liberty St., New York, N. Y.
Andrews Bradshaw Co., Blawnox, Pittsburgh, Pa.
Andrews Lead Co., 26-36 Greenpoint Ave., Long Island City, N. Y.
•Anemostat Corp. of America, 551 5th Ave., New York, N. Y.
Anetsberger Bros., 3505 Elston Ave., Chicago, Ill.
•Annis, Emmet F., 1515 Gardena St., Glendale, Cal.
Anson Industrial Co., 55 Front St., New York, N. Y.
Ansul Chemical Co., Marinette, Wis.
Antaciron, Inc., Tillman St., Raritan, N. J.
Apollo Steel Co., 609 Warren Ave., Apollo, Pa.
Aquatic Chemical & Metallurgical Engineers, 118 E. 28th St., New York, N. Y.
Arex Co., 333 N. Michigan Ave., Chicago, Ill.
Armour Ammonia Works, 1355 W. 31st St., Chicago, Ill.
Armstrong-Blum Mfg. Co., 333 N. Francisco Ave., Chicago, Ill.
Armstrong Bros. Tool Co., 317-357 N. Francisco Ave., Chicago, Ill.
•Armstrong Cork Products Co., 994 Concord St., Lancaster, Pa.
•Armstrong Machine Wks., 874 Maple St., Three Rivers, Mich.
Armstrong Mfg. Co., 303 Knowlton St., Bridgeport, Conn.
Ashton Valve Co., 161-1st St., Cambridge, Mass.
Atchison Revolving Door Co., Independence, Kans.
Athey Co., 1923 S. Calumet Ave., Chicago, Ill.
Athol Machine & Foundry Co., 621-631 S. Kolmar Ave., Chicago, Il.
Atlas Valve Co., Inc., 282 South St., Newark, N. J.
Auburn Stoker Corp., Auburn, Ind.
•Auditorium Conditioning Corp., 17 E. 42nd St., New York, N. Y.
•Auer Register Co., 3608 Payne Ave., Cleveland, O.
Austin-Mason Co., 15 Park Row, New York, N. Y.
Autoforce Ventilating System, 53 Devonshire St., Boston, Mass.

●Automatic Products Co., 2450 N. 32nd St., Milwaukee, Wis.
Automatic Reclosing Circuit Breaker Co., 601 W. 5th Ave., Columbus, O.
Automatic Stoker Corp., 1529 E. Beverly Rd., Milwaukee, Wis.
Automatic Switch Co., 154 Grand St., New York, N. Y.
Automatic Temperature Control Co., Inc., 34 E. Logan St. Philadelphia Pa.
●Autovent Fan & Blower Co., 1805-25 N. Kostner Ave., Chicago, Ill.

B

Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.
Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.
Bache & Co., Semon, Greenwich & Morton Sts., New York, N. Y.
Badger & Sons Co., E. B., 75 Pitts St., Boston, Mass.
Badger Fire Extinguisher Co., 31 St. James Ave., Boston, Mass.
Bahnson Co., R. J. Reynolds Bldg., Winston-Salem, N. C.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, O.
●Baker Ice Machine Co., Inc., 1509 Evans St., Omaha, Nebr.
Baldor Electric Co., 4353 Duncan Ave., St. Louis, Mo.
Ballantyne Co., 219 N. 16th St., Omaha, Nebr.
Balloffet Diamond Wire Dies Co., 45-51 Adams St., Guttenberg, N. J.
Baltimore Tube Co., Div. Revere Copper and Brass, Inc., 1301 Wicomico St., Baltimore, Md.
Barber Co., Inc., 16th & Arch Sts., Insurance Co. of North America Bldg., Philadelphia, Pa.
●Barber-Colman Co., 225 Loomis St., Rockford, Ill.
Barber Gas Burner Co., 3704 Superior Ave., Cleveland, O.
Barco Mfg. Co., 1801 Winnemac Ave., Chicago, Ill.
Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Boston, Mass.
Barnes Tool Co., 150 Brewery St., New Haven, Conn.
Barrett, Haentjens & Co., Hazelton, Pa.
Barrett Machine Co., 912-916 Behan St., N. S., Pittsburgh, Pa.
Bartlett Hayward Co., 200 Scott St., Baltimore, Md.
Bass Foundry & Machine Co., 1602-1734 Hanna St., Ft. Wayne, Ind.
Bastian-Blessing Co., 240 E. Ontario St., Chicago, Ill.
Bayley Blower Co., 1817 S. 66th St., Milwaukee, Wis.
Beach-Russ Co., 60A Church St., New York, N. Y.
Beaton & Cadwell Mfg. Co., 185 Main St., New Britain, Conn.
Beaton & Corbin Mfg. Co., Southington, Conn.
Beaver Pipe Tools, Inc., 310 Dana, N. E., Warren, O.
Belco Exhaust Fan Mfg. Co., 3810 Olive St., St. Louis, Mo.
Belfield Co., H., 435 N. Broad St., Philadelphia, Pa.
Belknap Mfg. Co., 800 Union Ave., Bridgeport, Conn.
Bell & Gossett Co., 3000 Wallace St., Chicago, Ill.
Belmont Packing & Rubber Co., Butler & Sepviva Sts., Philadelphia, Pa.
Belmont Smelting & Refining Wks., Inc., 348 Belmont Ave., Brooklyn, N. Y.
Bender Warrick Corp., 131 Pierce, Birmingham, Mich.
Bendix Products Corp., 401 Bendix Dr., South Bend, Ind.
Bennett Corp., W. M., 1109 Harney St., Omaha, Nebr.
Benson Co., Inc., Alex R., 1040 Bay Rd., So., Hudson, N. Y.
Berger Mfg. Co., Div. of Republic Steel Corp., 1038 Belden Ave., Canton, O.
Bernz Co., Inc., Otto, 280 Lyell Ave., Rochester, N. Y.
Berry, Jr., & Co., Inc., F. E., Irving St., Framingham, Mass.
Bertsch & Co., Inc., Church St., Cambridge City, Ind.
Best Register Co, 2005 W. Oklahoma Ave., Milwaukee, Wis.
Bethlehem Steel Co., Bethlehem, Pa.
Betz Unit Air Cooler Co., 6 W. 9th St., Kansas City, Mo.
Bigelow Co., 92 River St., New Haven, Conn.
Biggs Boiler Wks. Co., Bank St. and B. & O. R. R., Akron, O.
Bignall & Keeler Machine Wks., Edwardsville, Ill.
Billings & Spencer Co., 1 Laurel St., Hartford, Conn.
●Binks Mfg. Co., 3106 W. Carrol Ave., Chicago, Ill.
Bird-Archer Co., 90 West St., New York, N. Y.
Bishop & Babcock Sales Co., 4901 Hamilton Ave., Cleveland, O.
Black & Decker Mfg. Co., Pennsylvania Ave., Towson, Md.
Blackhawk Mfg. Co., Broadway & The River, Milwaukee, Wis.
Blackmer Pump Co., 1809 Century Ave., S. W., Grand Rapids, Mich.
Blair Products Co., 370 8th Ave., New York, N. Y.
Blood Brothers, Allegan, Mich.
Blower Application Co., 918 N. Fourth St., Milwaukee, Wis.
Blue Seal Chemical Co., 177 Westfield Ave., W., Roselle Park, N. J.
Bluffton Mfg. Co., 433 W. Main Cross St., Findlay, O.
Bodine Electric Co., 2254 W. Ohio St., Chicago, Ill.
●Bonney Forge & Tool Wks., Tilghman St. & Meadow St., Allentown, Pa.
Bordo Co., Inc., L. J., 115 New St., Glenside, Pa.
Bossert Corp., Inc., Lennox & Oswego Sts., Utica, N. Y.
Boston Auto Gage Co., 70 West St., Pittfield, Mass.
Boston Gear Works, Inc., North Quincy, Mass.
Bostwick-Goodell Co., Norwalk, O.
Bowser & Co., Inc., S. F., 1302 E. Creighton Ave., Fort Wayne, Ind.
Boylston Steam Specialty Co., 116-122 W. Illinois St., Chicago, Ill.
Bremil Mfg. Co., Erie, Pa.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
●Bristol Co., Platts Bridge, Waterbury, Conn.
Bros Boiler & Mfg. Co., Wm., Nicollet Island, Minneapolis, Minn.
Brown, Wm. P., 31 Sanford St., Springfield, Mass.
Brown-Brockmeyer Co., Inc., Overlook Ave., Dayton, O.
Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., 4534 Wayne Ave., Philadelphia, Pa.
Brown Sheet Iron & Steel Co., 964 Berry Ave., St. Paul, Minn.
Brownell Co., 300 N. Findlay St., Dayton, O.
Brunner Mfg. Co., 1821 E. Broad St., Utica, N. Y.
Bryan Steam Corp., P. O. Box 337, Peru, Ind.
Bryant Heater Co., 17825 St. Clair Ave., Cleveland, O.
Bubar, Hudson H., 15 Park Row, New York, N. Y.
●Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.
Buffalo Meter Co., 2917 Main St., Buffalo, N. Y.
●Buffalo Pumps, Inc., 171 Mortimer St., Buffalo, N. Y.
Buffalo Tank Co., Arlington, Staten Island, N. Y.
Builders Iron Foundry, 9 Codding St., Providence, R. I.
●Bullard Co., Brewster St. & Canfield Ave., Bridgeport, Conn.
Bundy Steam Trap Co., Nashua, N. H.
Burdett Mfg. Co., 15 N. Sheldon St., Chicago, Ill.
Burgess Battery Co., 111 W. Monroe St., Chicago, Ill.
Burhorn Co., Edwin, 1 Newark St., Hoboken, N. J.
Burke Electric Co., 1201 W. 12th St., Erie, Pa.
Burke Stoker & Mfg. Co., 921 W. 19th St., Chicago, Ill.
Burling Instrument Co., 241 Springfield Ave., Newark, N. J.
●Burnham Boiler Corp., Main St., Irvington, N. Y.
Burnham Stoker Co., 505 Columbia St., Vancouver, Wash.
Burnley Battery & Mfg. Co., Clay St., Northeast, Pa.
Burrows Mfg. Co., F. A., 1638 E. Market St., York, Pa.
Burrowes Corp., 70 Free St., Portland, Me.
Burt Air Filter Corp., Grand Central Terminal, New York, N. Y.
Burt Mfg. Co., 44 E. South St., Akron, O.
Bury Compressor Co., 18th & Cascade Sts., Erie, Pa.
Bush Mfg. Co., 100 Wellington St., Hartford, Conn.
Butler Mfg. Co., 13th & Eastern Ave., Kansas City, Mo.
Byers Co., A. M., Clark Bldg., Pittsburgh, Pa.

C

Cabot, Inc., Samuel, 141 Milk St., Boston, Mass.
Caldwell Co., W. E., 2120 Brook St., Louisville, Ky.
Caloroil Burner Corp., 1477 Park St., Hartford, Conn.
Campbell Heating Co., E. K., 2445 Charlotte St., Kansas City, Mo.
Campbell Heating Co., 31st & Dean, Des Moines, Ia.
Canton Stoker Corp., 407 Andrews Place, S. W., Canton, O.
Capitol Brass Division, Bohn Aluminum & Brass Corp., 2306 Franklin St., Detroit, Mich.
Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y.
●Carbondale Machine Corp., Worthington Ave., Harrison, N. J.
Carbo-Oxygen Co., Benedum-Trees Bldg., Pittsburgh, Pa.
Carey Co., Philip, Wayne Ave., Lockland, Cincinnati, O.
Carling Turbine Blower Co., 104 Harding St., Worcester, Mass.
Carnegie Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa.
Carpenter & Paterson, Inc., 1190 Bennington St., East Boston, Mass.
Carpenter Steel Co., Reading, Pa.
Carraway-Byrd Engineering Co., 613 N. Pearl St., Dallas, Tex.
Carrick Engineering Co., E. 8th St., Michigan City, Ind.
●Carrier Corp., 850 Frelinghuysen Ave., Newark, N. J.
Carty & Moore Engineering Co., 511 W. Larned St., Detroit, Mich.
Case & Son Mfg. Co., W. A., 33 Main St., Buffalo, N. Y.
Cash Co., A. W., P. O. Box 135, Decatur, Ill.
Cashin Co., W. D., 69 A St., Boston, Mass.
Celotex Co., 919 N. Michigan Ave., Chicago, Ill.
Central Brass Mfg. Co., 2950 E. 55th St., Cleveland, O.
Central Forging Co., Catawissa, Pa.
Central Foundry Co., 420 Lexington Ave., New York, N. Y.
Central Radiator Co., 420 Lexington Ave., New York, N. Y.
Central Station Steam Co., 2910 E. Woodbridge St., Detroit, Mich.
Central Tube Co., First National Bank Bldg., Pittsburgh, Pa.
Central Valve Mfg. Co., 255 E. 95th St., Chicago, Ill.
Centrifix Corp., 3029 Prospect Ave., Cleveland, O.
●Century Electric Co., 1806 Pine St., St. Louis, Mo.
Century Engineering Corp., 213-217 4th Ave., S. E., Cedar Rapids, Ia.
Certain-Teed Products Corp., 101 E. 41st St., New York, N. Y.
Certified Flexible Couplings, Inc., 122 E. 42nd St., New York, N. Y.
Chace Valve Co., W. M., 1606 Beard Ave., Detroit, Mich.
Chain Belt Co., 1644 W. Bruce, Milwaukee, Wis.
Chalmers Oil Burner Co., 1234 Central Ave., Minneapolis, Minn.
Chamberlin Metal Weather Strip Co., 1254 La Brosse St., Detroit, Mich.
Champion Blower & Forge Co., Harrisburg Ave. & Charlotte St., Lancaster, Pa.
Champion Machine & Forging Co., 3678 E. 78th St., Cleveland, O.

Chaplin-Fulton Mfg. Co., 28-40 Penn Ave., Pittsburgh, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Chelsea Metal Stamping Co., 95 8th Ave., New York, N. Y.
Cheney Co., Architects' Bldg., Philadelphia, Pa.
Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
Chicago Bridge & Iron Wks., 2124 Old Colony Bldg., Chicago, Ill.
Chicago Die Casting Mfg. Co., 2512 W. Monroe St., Chicago, Ill.
Chicago Expansion Bolt Co., 126 S. Clinton St., Chicago, Ill.
Chicago Metal Mfg. Co., 3724 S. Rockwell St., Chicago, Ill.
Chicago Nipple Mfg. Co., 1966 Southport Ave., Chicago, Ill.
Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N. Y.
Chicago Pump Co., 2336 Wolfram St., Chicago, Ill.
Chicago Specialty Mfg. Co., 332 N. Western Ave., Chicago, Ill.
Chicago Venetian Blind Co., 3105 W. 27th St., Chicago, Ill.
Chicago-Wilcox Mfg. Co., E. 77th St. & Anthony Ave., Chicago, Ill.
Chisholm Co., Allen E., 2640 E. Burnside St., Portland, Ore.
Cissell Mfg. Co., W. M., 831 S. First St., Louisville, Ky.
Christensen Machine Co., 1975 S. 2nd West St., Salt Lake City, Utah.
Cincinnati Shaper Co., Hopple, Garrard & Elam, Cincinnati, O.
Cincinnati Sheet Metal & Roofing Co., 230 E. Front St., Cincinnati, O.
•Clarage Fan Co., Porter St., Kalamazoo, Mich.
•Clark Controller Co., 1146 E. 152 St., Cleveland, O.
Clark Equipment Co., Buchanan, Mich.
Clauss Shear Co., Fremont, O.
Clayton & Lambert Mfg. Co., 11111 French Rd., Detroit, Mich.
Cleaver-Brooks Co., 135 W. Wells St., Milwaukee, Wis.
Cleghorn Co., Broad & Franklin Sts., Boston, Mass.
Clizbe Bros. Mfg. Co., Plymouth, Ind.
Clow, Jas. B., & Sons, 201 N. Talman Ave., Chicago, Ill.
Cochrane Corp., 3161 N. 17th St., Philadelphia, Pa.
Coe Mfg. Co., Bank St., Painesville, O.
Cohoes Rolling Mill Co., Canvass & Cortland Sts., Cohoes, N. Y.
Colebrooks Sons, Inc., W. H., Syracuse, N. Y.
Columbia Mills, Inc., Saginaw, Mich.
Columbian Steel Tank Co., 1509 W. 12th St., Kansas City, Mo.
Columbus Heating & Ventilating Co., 400 Dublin Ave., Columbus, O.
Columbus Humidifier Co., 154 N. 5th St., Columbus, O.
Columbus Metal Products Co., 767 N. 4th St., Columbus, O.
Columbus Steam Pump Wks. Co., 724 Broderick St., Columbus, O.
Combination Boiler Co., Benton Harbor, Mich.
Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y.
Commodore Heaters Corp., 11 W. 42nd St., New York, N. Y.
Commonwealth Brass Corp., 5781-5835 Commonwealth Ave., Detroit, Mich.
Commonwealth Mfg. Corp., 4208 Davis Lane, Cincinnati, O.
Conditionaire Unit Co., 2821 Montrose Ave., Chicago, Ill.
Conneaut Packing Co., Conneaut, O.
Connery Construction Co., 2nd & Luzerne Sts., Philadelphia, Pa.
Consolidated Air Conditioning Corp., 114 E. 32nd St., New York, N. Y.
Consolidated Ashcroft Hancock Co., Inc., 11 Elias St., Bridgeport, Conn.
Continental Diamond Fibre Co., Newark, Del.
Continental Motors Corp., 12802 Jefferson Ave., E., Detroit, Mich.
Continental Electric Co., Inc., 323 Ferry St., Newark, N. J.
Continental Rubber Wks., 1905 Liberty Blvd., Erie, Pa.
Continental Steel Corp., 1108 S. Main St., Kokomo, Ind.
Continental Stove Corp., Front & Walnut Sts., Ironton, O.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cooling Tower Co., Inc., 15 John St., New York, N. Y.
Cooper Co., Clark, 159 Jefferson St., Philadelphia, Pa.
Cooper Sanitary Co., 3336 Chestnut St., Philadelphia, Pa.
Copeland Refrigeration Corp., 1331 Holden Ave., Detroit, Mich.
Coppus Engineering Corp., 374 Park Ave., Worcester, Mass.
•Cork Import Corp., 330 W. 42nd St., New York, N. Y.
•Cork Insulation Co., Inc., 155 E. 44th St., New York, N. Y.
Corley Co., 629 Grove St., Jersey City, N. J.
Cornell Wood Products Co., 230 N. Michigan Ave., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Corozone Air Conditioning Corp., 1422 Euclid Ave., Cleveland, O.
Crandall Packing Co., Palmyra, N. Y.
•Crane Co., 836 S. Michigan Ave., Chicago, Ill.
Crane Packing Co., 1801 Belle Plaine Ave., Chicago, Ill.
Crawford Co., 3220 W. 31st St., Chicago, Ill.
Crew-Taylor Engineering Corp., 305 E. 45th St., New York, N. Y.
Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.
Croll & Son, Jesse G., 2326-2606 Germantown Ave., Philadelphia, Pa.
Croll-Reynolds Engineering Co., Inc., 17 John St., New York, N. Y.
Cross Engineering Co., 160-178 Dundaff St., Carbondale, Pa.
Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.
Cuno Engineering Corp., 80 S. Vine St., Meriden, Conn.
Curtis & Curtis Co., 218 Garden St., Bridgeport, Conn.
•Curtis Refrigerating Machine Co., 1950 Kienlen Ave., St Louis, Mo.
Cutler-Hammer, Inc., N. 12th St. & W. St. Paul Ave., Milwaukee, Wis.

D

Dahlquist Mfg. Co., Inc., 40 W. 3rd St., Boston, Mass.
Dallas Engineering Corp., 1115 Hall, Dallas, Tex.
Dampney Co. of America, 1243 River St., Hyde Park, Boston, Mass.
Darcoid Co., Inc., 200 Varick St., New York, N. Y.
Darling Valve & Mfg. Co., 701 Walnut St., Williamsport, Pa.
•Dart Mfg. Co., E. M., 134 Thurber Ave., Providence, R. I.
Davenport Mfg., Co., 301 W. College St., Meadville, Pa.
Davidson Co., M. T., 154 Nassau St., New York, N. Y.
Davies Air Filter Co., 390 Fourth Ave., New York, N. Y.
Davis Engineering Corp., 1064 E. Grand St., Elizabeth, N. J.
Davis Regulator Co., 2546 S. Washtenaw Ave., Chicago, Ill.
Dayton Air Compressor Co., Dayton, O.
Dayton-Dowd Co., 115-17 York St., Quincy, Ill.
Dayton Rubber Mfg. Co., 2345 W. Riverview Ave., Dayton, O.
Dean Bros. Co., 323 W. 10th St., Indianapolis, Ind.
Dean Hill Pump Co., Anderson, Ind.
De Bothezat Div., American Machine & Metal Mfg. Corp., 100-6th Ave., New York, N. Y.
Decatur Pump Co., 2750 Nelson Park Rd., Decatur, Ill.
Defender Automatic Regulator Co., 308 S. 8th St., St. Louis, Mo.
De Laval Steam Turbine Co., 300 Nottingham Way, Trenton, N. J.
De La Vergne Engine Co., Philadelphia, Pa.
Delco-Frigidaire Conditioning Div., General Motors Sales Corp., 1420 Wisconsin Blvd., Dayton, O.
Delco Products Corp., 329 E. First St., Dayton, O.
Delta-Star Electric Co., 2400 Block, W. Fulton St., Chicago, Ill.
Delta Stoker Co., Foot of Commonwealth, North Chicago, Ill.
•Deming Co., 14 Aetna St., Salem, O.
Desolvo Mfg. Co., 33 Terminal Way, Pittsburgh, Pa.
d'Este Co., Julian, 6 Spice St., Charlestown, Mass.
Detroit Brass & Malleable Works, 100 S. Campbell, Detroit, Mich.
Detroit Graphite Co., 550 12th St., Detroit, Mich.
•Detroit Lubricator Co., 5900 Trumbull Ave., Detroit, Mich.
Detroit Seamless Steel Tubes Co., c/o Grand River Station, Detroit, Mich.
•Detroit Stoker Co., Sales and Engineering Offices, General Motors Bldg., Detroit, Mich.; Works at Monroe, Mich.
•Detroit Stoker Co. of Canada, Ltd., Canada Bldg., Windsor, Ont.; Works at London, Ont.
De Vilbiss Co., 300 Phillips St., Toledo, O.
Devine Mfg. Co., Inc., J. P., 909 Shawnee Ave., Mt. Vernon, Ill.
Devlin Mfg. Co., Inc., Thomas, Burlington, N. J.
D. G. C. Trap & Valve Co., Inc., 366 Madison Ave., New York, N. Y.
Diamond Chain & Mfg. Co., 400 Kentucky Ave., Indianapolis, Ind.
Diamond Expansion Bolt Co., 500 North Ave., Garwood, N. J.
Diamond Mfg. Co., 253 W. Eighth St., Wyoming, Pa.
Dick Co., Inc., R. & J., 24-48 Sade St., Passaic, N. J.
Diehl Mfg. Co., Trumbull St., Elizabethport, N. J.
Dillon Steam Boiler Wks., Inc., D. M., Crocker St., Fitchburg, Mass.
Direct Separator Co., Inc., 218 S. Geddes St., Syracuse, N. Y.
Dissolene Corp., Hempstead, N. Y.
Dixie Mfg. Co., Inc., 1310 Russell St., Baltimore, Md.
Dixon Crucible Co., Joseph, Wayne & Monmouth Sts., Jersey City, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
Dole Valve Co., 1901-33 Carroll Ave., Chicago, Ill.
Domestic Engine & Pump Co., 30 Church St., New York, N. Y.
Downingtown Iron Wks., Wallace Ave., Downingtown, Pa.
Dracco Corp., 4057 E. 116th St., Cleveland, O.
Dravo-Doyle Co., Dravo Bldg., Pittsburgh, Pa.
Dreis & Krump Mfg. Co., 7404 Loomis Blvd., Chicago, Ill.
Dresser Mfg. Co., S. R., 41 Fisher Ave., Bradford, Pa.
Duckworth-Elsey Metal Products Co., 1535 Spruce St., Detroit, Mich.
•Dunham Co., C. A., 450 E. Ohio St., Chicago, Ill.
Dunn Inc., Struthers, 153 N. Juniper St., Philadelphia, Pa.
du Pont de Nemours & Co., E. I., R. & H. Chemicals Dept., Niagara Falls, N. Y.
Durabla Mfg. Co., 114 Liberty St., New York, N. Y.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Duraloy Co., S. 26th St., Pittsburgh, Pa.
Duriron Co., Inc., 450 N. Findlay St., Dayton, O.
Dusinberre Indicator Co., 101 Quentin St., Kew Gardens, N. Y.

E

Eagle-Picher Lead Co., Temple Bar Bldg., Cincinnati, O.
Eastman Kodak Co., Kodak Park, Rochester, N. Y.
Eclipse Fuel Engineering Co., 707 S. Main St., Rockford, Ill.
Econocol Stoker Div. of Cotta Transmission Corp., 2340 11th St., Rockford, Ill.
Economy Electric Mfg. Co., 4634 W. 21st Pl., Chicago, Ill.

Economy Equipment Co., 538 W. Pershing Rd., Chicago, Ill.
Economy Pumping Machinery Co., Inc., 3431 W. 48th Pl., Chicago, Ill.
Eddy Stoker Corp., 4717 W. North Ave., Chicago, Ill.
Eddy Valve Co., Waterford, N. Y.
Edge Moor Iron Wks., 30 Rockefeller Plaza, New York, N. Y.
Edison, Inc., Thomas A., Edison Electrical Controls Div., Lakeside Ave., West Orange, N. J.
Edward Valve & Mfg. Co., 1200 W. 145th St., East Chicago, Ind.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Eisler Electric Corp., 754 S. 13th St., Newark, N. J.
Electric Air Heater Co., Division of American Foundry Equipment Co., 555 Byrkit St., Mishawaka, Ind.
Electric Auto-Lite Co., Moto Meter Gauge & Equipment Div., Caledonia & Gillette Sts., La Crosse, Wis.
Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, O.
Electric Hot Heater Co., 4302 S. Tacoma Way, Tacoma, Wash.
Electric Machinery Mfg. Co., 1331 Tyler St., N. E., Minneapolis, Minn.
Electric Valve Mfg. Co., Inc., 68 Murray St., New York, N. Y.
Electrical Research Laboratories, Warren, Pa.
●Electrimatic Corp., 2100 Indiana Ave., Chicago, Ill.
Electroaire Corp., 1455-57 W. Congress St., Chicago, Ill.
Electrol, Inc., 934 Main Ave., Clifton, N. J.
Electrovent Fan & Mfg. Co., 737 W. Washington Blvd., Chicago, Ill.
Elgin Softener Corp, Elgin, Ill.
Elgo Shutter & Mfg. Co., 634 W. Warren Ave., Detroit, Mich.
Elliott Co., Jeannette, Pa.
Ellis Drier Co., 2444 N. Crawford Ave., Chicago, Ill.
Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Endura Mfg. Corp., 45 N. 4th St., Quakertown, Pa.
Engineer Co., 17 Battery Pl., New York, N. Y.
Enterprise Oil Burner Co., 2902 19th St., San Francisco, Cal.
Erdle Perforating Co., 171 York St., Rochester, N. Y.
Erie City Iron Wks., 1500 East Ave., Erie, Pa.
Erie Tool Wks., 11th & French Sts., Erie, Pa.
Everlasting Valve Co., 49 Fisk St., Jersey City, N. J.
Evry-Use Products, Inc., 260 Canal St., New York, N. Y.
Excelsior Steel Furnace Co., 118 So. Clinton St., Chicago, Ill.
Excelsior Tool & Machine Co., 31st & Ridge Ave., East St. Louis, Ill.
Excelso Products Corp., 65 Clyde Ave., Buffalo, N. Y.

F

Fabling Co., W. D., 722 N. Broadway, Los Angeles, Cal.
●Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
●Fairbanks Co., 396 Lafayette St., New York, N. Y.
●Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.
Fairmont Aluminum Co., Fairmont, W. Va.
Falstrom Co., Passaic, N. J.
Farley Sleeve & Hanger Co., 3748 E. 71st St., Cleveland, O.
Farquhar Co., Ltd., A. B., Duke St., York, Pa.
Farrar & Trefts, 9 Grimes St., Buffalo, N. Y.
●Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y.
Fee and Stemwedel, Inc., 221 W. Chicago Ave., Chicago, Ill.
Felt Products Mfg. Co., 1523 Carroll Ave., Chicago, Ill.
Ferguson & Lange Foundry Co., 1039 Willow St., Chicago,Ill.
Ferro-Nil Corp., 500 Fifth Ave., New York, N. Y.
Filtrine Mfg. Co., Inc., 53 Lexington Ave., Brooklyn, N. Y.
Firemood Machine Wks., Converse, Ind.
Firestone Tire & Rubber Co., S. Main St., Akron, O.
Fir-Tex Insulating Board Co., St. Helens, Ore.
Fisher Governor Co., 102-17 S. First St., Marshalltown, Ia.
●Fitzgibbons Boiler Co., Inc., 101 Park Ave., New York, N. Y.
Flagg & Co., Inc., Stanley G., 1421 Chestnut St., Philadelphia, Pa.
Flemm Lead Co., Inc., Bradley Ave. & School St., Long Island City, N. Y.
Flexitallic Gasket Co., 8th & Bailey Sts., Camden, N. J.
Flexo Supply Co., Inc., 4221 Olive St., St. Louis, Mo.
Floersheim & Co., B., Farmers Bank Bldg., Pittsburgh, Pa.
Fluor Corp., 909 E. 59th St., Los Angeles, Cal.
Flynn & Emrich Co., 301 N. Halliday St., Baltimore, Md.
Follansbee Bros. Co., 3rd & Liberty Aves., Pittsburgh, Pa.
Forest City Foundries Co., 2500 W. 27th St., Cleveland, O.
●Forslund Pump & Machinery Co., 1717-19 Main St., Kansas City, Mo.
Foster Engineering Co., 109 Monroe St., Newark, N. J.
Foster Pump Wks., Inc., 46 Washington St., Brooklyn, N. Y.
Foster Wheeler Corp., 165 Broadway, New York, N. Y.
Fowler & Wolfe Radiator Co., Oak & Carson Sts., Norristown, Pa.
Foxboro Co., 106 Neponset Ave., Foxboro, Mass.
France Packing Co., 6512 Tacony St., Tacony, Philadelphia, Pa.
Frank Engineering Co., 11 Park Place, New York, N. Y.
Frederick Iron and Steel Co., E. 7th St., Frederick, Md.
French Rotary Oil Burner Co., P. O. Box N, Sebastopol, Cal.
Fresh-'nd-Aire Co., 430 W. Erie St., Chicago, Ill.
Fulflo Specialties Co., Blanchester, O.
●Fretz-Moon Tube Co., Inc., Butler, Pa.
●Frick Co., Waynesboro, Pa.
●Friez & Sons, Inc., Julien P., 4 N. Central Ave., Baltimore, Md.
Frost Mfg. Co., S. Henderson St., Galesburg, Ill.
Fuel Savers, Inc., 15th & Herr Sts., Harrisburg, Pa.
Fuller Co., 124 Bridge St., Catasauqua, Pa.
Fulton Sylphon Co., Knoxville, Tenn.

G

G. M. Mfg. Co., P. O. Box 151, Madison Square Sta., New York, N. Y.
Garden City Fan Co., 332 S. Michigan Ave., Chicago, Ill.
Gardiner Metal Co., 2514 W. 48th Pl., Chicago, Ill.
Gardner, Bernard, 632 W. 130th St., New York, N. Y.
Gardner-Denver Co., Quincy, Ill.
Garlock Packing Co. 50 Main St., Palmyra, N. Y.
Gasweld & Airway, Inc., 625 W. Jackson Blvd., Chicago, Ill.
Gates Rubber Co., 999 S. Broadway, Denver, Col.
Gatke Corp., 228 N. La Salle St., Chicago, Ill.
Gehl Bros. Mfg. Co., West Bend, Wis.
General Air Conditioning Corp., 4411 Appleton St., Cincinnati, O.
General Bronze Corp., Hancock & Boulevard, Long Island City, N. Y.
General Ceramics Co., 71 W. 35th St., New York, N. Y.
●General Controls Co., 1370 Harrison St., San Francisco, Cal. and 1505 Broadway, Cleveland, O.
General Electric Co., 1 River Rd., Schenectady, N. Y.
General Equipment Co., 315 S. Wichita, Wichita, Kan.
General Fittings Co., 100 Baker St., Providence, R. I.
General Gas Light Co., 212 N. Park, Kalamazoo, Mich.
General Insulating & Mfg. Co., 125 Fairview Ave., Alexandria, Ind.
General Insulating Products Co., 8821 15th Ave., Brooklyn, N. Y.
General Plate Co., 34 Forrest St., Attleboro, Mass.
General Refrigeration Sales Co., Shirland Ave., Beloit, Wis.
Gerstein & Cooper Co., 1 W. Third St., South Boston, Mass.
Geuder, Paeschke & Frey Co., W. St. Paul Ave. & N. 15th St., Milwaukee, Wis.
Giant Grip Mfg. Co., 30 Osceola St., Oshkosh, Wis.
Gilbert & Barker Mfg. Co., Cold Spring Ave., Springfield, Mass.
Gilmer Company, L. H., Keystone & Cottman Sts., Tacony, Phfiadelphia, Pa.
Gleason-Avery, Inc., 27 Clark St., Auburn, N. Y.
Globe Machine & Stamping Co., 1220 W. 76th St., Cleveland, O.
Globe Ventilator Co., 205 River St., Troy, N. Y.
Glore Sales Corp., Evins F., 1949 Grand Central Terminal Bldg., New York, N. Y.
G & O Mfg. Co., 138 Winchester Ave., New Haven, Conn.
Goethel Co., Alfred C., 2337 N. 31st St., Milwaukee, Wis.
Goethel Sheet Metal Wks., Alfred, 1910 N. Killian Pl., Milwaukee, Wis.
Goetz Gasket & Packing Co., Inc., 60 Allen Ave., New Brunswick, N. J.
Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburgh, Pa.
Goodell-Pratt Co., 57 Wells St., Greenfield, Mass.
Goodrich Co., B. F., 548 S. Main St., Akron, O.
Goodyear Tire & Rubber Co., E. Market St., Akron, O.
Gorton Heating Corp., Cranford, N. J.
Goulds Pumps, Inc., Fall St., Seneca Falls, N. Y.
Grabler Mfg. Co., 6565 Broadway, Cleveland, O.
Graham Mfg. Co., Inc., 220 Delaware Ave., Buffalo, N. Y.
Grand Rapids Blow Pipe & Dust Arrester Co., 525-28 Monroe Ave., Grand Rapids, Mich.
Granite City Steel Co., 20th & Madison Ave., Granite City, Ill.
Graton & Knight Mfg. Co., 356 Franklin St., Worcester, Mass.
Graver Tank & Mfg. Co., Inc., 4809 Todd Ave., East Chicago, Ind.
Greene, Tweed & Co., 109 Duane St., New York, N. Y.
Greenfield Tap & Die Corp., Sanderson St., Greenfield, Mass.
●Grinnell Co., Inc., 260 W. Exchange, Providence, R. I.
Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Guardian Utilities Co., 1023 E. 46th St., Chicago, Ill.
Guild & Garrison, Inc., 463 Kent Ave., Brooklyn, N. Y.
Gulf States Steel Co., Brown-Marx Bldg., Birmingham, Ala.
Guth Co., Edwin F., 2615 Washington Blvd., St. Louis, Mo.

H

Haering Co., Inc., D. W., 3408 W. Monroe St., Chicago, Ill.
Hagan Corp, 502 Bowman Bldg., Pittsburgh, Pa.
Haines & Co., William S., 12th & Buttonwood Sts., Philadelphia, Pa.
Hamburg Boiler Wks., Inc., Grand St., Hamburg, Pa.
Hamilton Rubber Mfg. Co., Mead St., Trenton, N. J.
Hammett Mfg. Co. 1907 Holmes St., Kansas City, Mo.
Hammond Brass Wks., Summer Blvd., Hammond, Mich.
Hampden Cornice Wks., Inc., 300 Birnie Ave., Springfield, Mass.
Handy & Harman, 82 Fulton St., New York, N. Y.
Hardinge Oil Burner Co., 1770 Berteau St., Chicago, Ill.
Hardy Mfg. Co., Inc., 100 Davis Ave., Dayton, O.
Harnischfeger Corp., 440 W. National Ave., Milwaukee, Wis.
Harrington & King Perforating Co., 5655 Fillmore St., Chicago, Ill.
Harris & Co., Arthur, 210 N. Curtis St., Chicago, Ill.
Harris Calorific Co., 5501 Cass Ave., N. W., Cleveland, O.
Harrisburg Foundry & Machine Co., Inc., 7th & Curtin St., Harrisburg, Pa.
Harrisburg Steel Corp., 10th & Herr Sts., Harrisburg, Pa.

Hart & Cooley Mfg. Co., 61 W. Kinzie St., Chicago, Ill.
Hart & Crouse Co., Inc., 301 Turner St., Utica, N. Y.
Hart Mfg. Co., 115 Bartholomew Ave., Hartford, Conn.
Hartmann Co., Chas., 985 Dean St., Brooklyn, N. Y.
Hartzell Propeller Fan Co., P. O. Box 909, Roosevelt Ave., Piqua, O.
Hasco Valve & Machine Co., 1819 W. St. Paul Ave., Milwaukee, Wis.
Hays Corp., E. 8th St., Michigan City, Ind.
Hays Mfg. Co., 801 W. 12th St., Erie, Pa.
H-B Instrument Co., 2518 N. Broad St., Philadelphia, Pa.
Heartley Machine & Tool Co., 900-8 Summit Ave., Toledo, O.
Heating Assurance, Inc., 121-123 N. Browne, Spokane, Wash.
Heat Transfer Co., Huntington, Ind.
Hegeler Zinc Co., P. O. Box 599, Danville, Ill.
Heil Co., 3000 Montana St., Milwaukee, Wis.
Hendley & Whittemore, 6 Blackhawk Blvd., Beloit, Wis.
Hendrick Mfg. Co., 37 Dundaff St., Carbondale, Pa.
●Henry Furnace & Foundry Co., 3480 E. 49th St., Cleveland, O.
Henry Valve Co., 1019 N. Spaulding Ave., Chicago, Ill.
Herbert Boiler Co., Root & La Salle Sts., Chicago, Ill.
Her-Born Engineering & Mfg. Co., 212 Columbus Ave., Sandusky, O.
Hercules Chemical Co., Inc., 332 Canal St., New York, N. Y.
Hercules Float Wks., 200 Franklin St., Springfield, Mass.
Hexcel Radiator Co., 18th St. & Fleet Ave., Racine, Wis.
Higgin Mfg. Co., Newport, Ky.
Hirschman Co., W. F., 220 Delaware Ave., Buffalo, N. Y.
Hobart Bros. Co., Canal Lock Sq., Troy, O.
Hodge Boiler Wks., Summer St., East Boston, Mass.
Hodgman Mfg. Co., 135 Washington St., Taunton, Mass.
Hoffman Combustion Engineering Co., 410 Ford Bldg., Detroit, Mich.
●Hoffman Specialty Co., Inc., Waterbury Natl. Bank Bldg., Waterbury, Conn.
Holcomb & Hoke Mfg. Co., 1545 Van Buren, Indianapolis, Ind.
Hollands Mfg. Co., Erie, Pa.
Hollup Corp., 3357 W. 47th Pl., Chicago, Ill.
●Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Homestead Valve Mfg. Co., P. O. Box H, Coraopolis, Pa.
Hoosick Engineering Co., Inc., Branch No. 1, 23 Elm St., Hoosick Falls, N. Y.
Hoppes Mfg. Co., 850 N. Belmont Ave., Springfield, O.
Horton Mfg. Co., 3016 University Ave., S. E., Minneapolis, Minn.
Hotstream Heater Co., 8007 Grand Ave., Cleveland, O.
Hough Co., Janesville, Wis.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Pa.
Hound Packing Co., 4757 E. Ravenswood Ave., Chicago, Ill.
Howard Iron Wks. & Alberger Heater Co., 287 Chicago St., Buffalo, N. Y.
Howe Ice Machine Co., 2825 Montrose Ave., Chicago, Ill.
Howell Electric Motors Co., Howell, Mich.
Howell Mfg. Co., 1625 Cleveland, Kansas City, Mo.
Hugo Mfg. Co., 49th Ave., W., & Superior St., West Duluth, Minn.
Hull Mfg. Co., Pennsylvania & Prospect Ave., Hagerstown, Md.
Humidi-Cooler Corp., New Haven, Conn.
Hussey & Co., C. G., 2850 Second Ave., Pittsburgh, Pa.
Hyatt Roller Bearing Co., Harrison, N. J.
Hynes Electric Heating Co., 240 Cherry St., Philadelphia, Pa.

I

●Ideal Commutator Dresser Co., 1096 Park Ave., Sycamore, Ill.
Ideal Electric & Mfg. Co., E. First & Oak Sts., Mansfield, O.
Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill.
Illinois Engineering Co., 2035 S. Racine Ave., Chicago, Ill.
Illinois Iron & Bolt Co., 918 S. Michigan Ave., Chicago, Ill.
Illinois Malleable Iron Co., 1801 Diversey Ave., Chicago, Ill.
●Illinois Testing Laboratories, 420 N. LaSalle St., Chicago, Ill.
Illinois Zinc Co., 332 S. Michigan Ave., Chicago, Ill.
Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago, Ill.
Imperial Electric Co., 64 Ira Ave., Akron, O.
●Independent Air Filter Co., 215 W. Ohio St., Chicago, Ill.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
●Independent Register Co., 3747 E. 93rd St., Cleveland, O.
Indian Refining Co., 5 E. Market, Indianapolis, Ind.
Industrial Apparatus Co., 720 N. Wabash Ave., Chicago, Ill.
●Ingersoll-Rand, 11 Broadway, New York, N. Y.
Ingersoll Steel & Disc Co., 310 S. Michigan Ave., Chicago, Ill.
Inland Mfg. Co., 1120 N. Cicero Ave., Chicago, Ill.
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Insto-Gas Corp., 1900 E. Jefferson, Detroit, Mich.
Insulite Co., 1100 Builders Exchange Bldg., Minneapolis, Minn.
Inter-Coastal Paint Corp., 15th St. and Southern R. R., East St. Louis, Ill.
International Boiler Works Co., East Stroudsburg, Pa.
International Draft Control Co., 6611 Euclid Ave., Cleveland, O.
International Engineering, Inc., 1145 Bolander Ave., Dayton, O.
International Engineering Wks., Inc., Box "B," Framingham, Mass.
International Heater Co., 101 Park Ave., Utica, N. Y.
International Moistening Co., 36 Exchange Pl., Providence, R. I.
International Nickel Co., 67 Wall St., New York, N. Y.
International Nutyp Tool Corp., 68 W. First St., Oswego, N. Y.
International Vermiculite Co., 11th & Stanford Ave., Springfield, Ill.
Iona Ventilator Co., Inc., 2821-29 W. Dauphin St., Philadelphia, Pa.
Iron Fireman Mfg. Co., 3170 W. 106th St., Cleveland, O.

J

Jackson Co., Byron, Ft. Carlton St., Berkeley, Cal.
Jamar Co., Walker, 367 S. First Ave. E., Duluth, Minn.
Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill.
Jarecki Mfg. Co., 1345 W. 12th St., Erie, Pa.
Jefferson Electric Co., 25th & Madison St., Bellwood, Ill.
Jefferson Union Co., Lexington, Mass.
Jeffrey Mfg. Co., 956 N. Fourth St., Columbus, O.
Jenkins Bros., 80 White St., New York, N. Y.
Jenkins Mfg. Co., 2 W. 45th St., New York, N. Y.
Jennison Co., 17 Putnam St., Fitchburg, Mass.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Johnson Co., S. T., 940 Arlington St., Oakland, Cal.
Johnson Corp., 830 Wood St., Three Rivers, Mich.
Johnson Fan & Blower Corp., 1319 W. Lake St., Chicago, Ill.
Johnson Mfg. Co., 10th & Sycamore, Waterloo, Ia.
●Johnson Service Co., 507 E. Michigan St., Milwaukee, Wis.
Johnson Tool Co., 65-67 Massasoit Ave., East Providence, R. I.
Johnston & Jennings Co., 877 Addison Rd., Cleveland, O.
Johnston Bros., Inc., Ferrysburg, Mich.
Johnston Co., William W., 115 Bayard St., Dayton, O.
Joliet Heating Corp., 2101 Herkimer St., Joliet, Ill.
Jones Foundry Machine Co., W. A., 4401 W. Roosevelt Rd., Chicago, Ill.
Jones & Laughlin Steel Corp., Third & Ross St., Pittsburgh, Pa.
Jordan & Co., Paul R., 631 S. Delaware St., Indianapolis, Ind.
Justus Steam Trap Co., Napanoch, N. Y.

K

Kainer & Co., 761 W. Lexington, Chicago, Ill.
Kaiseraire Products Sales Co., 936 W. Chicago Ave., Chicago, Ill.
Kane Mfg. Co., Kane, Pa.
Kauffman Air Conditioning Corp., 4485 Olive St., St. Louis, Mo.
Kaye & MacDonald, Inc., 92 Franklin Ave., West Orange, N. J.
Keasbey & Mattison Co., Butler Ave., Ambler, Pa.
Keasbey Co., Robert A., 139-149 W. 19th St., New York, N. Y.
Keckley Co., O. C., 565 W. Washington Blvd., Chicago, Ill.
Keeler Co., E., 238 West St., Williamsport, Pa.
Keeney Mfg. Co., Main St., Newington, Conn.
Kellogg Co., M. W., 225 Broadway, New York, N. Y.
Kellogg Compressor & Mfg. Co., 97 Humboldt St., Rochester, N. Y.
Kelly-Koet, Covington, Ky.
●Kelvinator Corp., 14250 Plymouth Rd., Detroit, Mich.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kernchen Co., 103 E. Wacker Drive, Chicago, Ill.
Kerotest Mfg. Co., 2525 Liberty Ave., Pittsburgh, Pa.
Kester Solder Co., 4201 Wrightwood Ave., Chicago, Ill.
●Kewanee Boiler Corp., Kewanee, Ill.
Key Boiler Equipment Co., 333 S. 27th St., East St. Louis, Ill.
Kidder Mfg. Co., Inc., J. F., 426 Colchester Ave., Burlington, Vt.
Kieley & Mueller, Inc., 34 W. 13th St., New York, N. Y.
Kinetic Chemicals, Inc., 10th & Market St., Wilmington, Del.
King-Seeley Corp., 302 Second St., Ann Arbor, Mich.
King Union Co., Inc., Hillsgrove, R. I.
King Ventilating Co., Box 178, Owatonna, Minn.
Kingsford Foundry & Machine Wks., 264 W. Second St., Oswego, N. Y.
Kinney Mfg. Co., 3529 Washington St., Boston, Mass.
Kirk & Blum Mfg. Co., 2838-52 Spring Grove Ave., Cincinnati, O.
Kisco Boiler & Engineering Co., 4333 Duncan Ave., St. Louis, Mo.
Kleenaire Corp., 409 Jefferson St., Stevens Point, Wis.
Kleen-Heet, Inc., 1823 Carroll Ave., Chicago, Ill.
Klingerit, Inc., 16-22 Hudson St., New York, N. Y.
Klipfel Mfg. Co., 2651 W. Harrison St., Chicago, Ill.
Knickerbocker Co., Jackson, Mich.
Knight, Maurice A., Kelly Ave., Akron, O.
Knowles Mushroom Ventilator Co., 41 N. Moore St., New York, N. Y.
Kol-Master Corp., Oregon, Ill.
Kool-Kleen Air Conditioner Co., E. 7th & Division St., Sioux City, Ia.
Kopperman & Sons, Joseph B., 316 New St., Philadelphia, Pa.
Korfund Co., 48-15 32nd Pl., Long Island City, N. Y.
Koven & Bro., L. O., 154 Ogden Ave., Jersey City, N. J.
●Kuhns Bros. Co., 1800 McCall St., Dayton, O.

L

La Bour Pump Co., Inc., 1301 Sterling Ave., Elkhart, Ind.
Laclede Steel Co., Arcade Bldg., Rm. 1317, St. Louis, Mo.
Laclede Stoker Co., 4438 Hunt Ave., St. Louis, Mo.
Lammert & Mann Co., 281 N. Wood St., Chicago, Ill.
Lamneck Products, Inc., 416-36 Dublin Ave., Columbus, O.

Lamson & Sessions Co., 1971 W. 85th St., Cleveland, O.
Landis Machine Co., 5th & Church Sts., Waynesboro, Pa.
Larkin Packer Co., 6200 Maple Ave., St. Louis, Mo.
Larkin Refrigerating Corp., 519 Fair St., S. E., Atlanta, Ga.
Lawler Automatic Controls, Inc., 453 N. MacQuesten Pkwy., Mount Vernon, N. Y.
Lawrence Pump & Engine Co., P. O. Box 70, Lawrence, Mass.
●Layne & Bowler, Inc., Memphis, Tenn.
Lead Lined Iron Pipe Co., 1 Broadway, Wakefield, Mass.
Leavitt Machine Co., East River St., Orange, Mass.
Lecourtenay Co., 5 Maine St., Newark, N. J.
Lee Heating Systems, Federal & Reserve Sts., Youngstown, O.
Lee & Son Co., Thomas, 128-132 W. Second St., Cincinnati, O.
Leeds & Northrup Co., 4952 Stenton Ave., Philadelphia, Pa.
Leffel & Co., James, 426 East St., Springfield, O.
Lehigh Fan & Blower Co., Front & Linden Sts., Allentown, Pa.
Leiman Bros., Inc., 146-181 Christie St., Newark, N. J.
●Leland Electric Co., 1501 Webster St., Dayton, O.
Lennox Furnace Co., 200 Lincoln Highway, Marshalltown, Ia.
Leonard-Rooke Co., 1360 Elmwood Ave., Providence, R. I.
Leslie Co., Valley Brook & Brant Aves., Lyndhurst, N. J.
Lewis & Co., Inc., Chas. S., 2207 Pine St., St. Louis, Mo.
Lewis Air Conditioners, Inc., 1600 Broadway, N. E., Minneapolis, Minn.
●Lilie-Hoffman Cooling Towers, Inc., 4948 Reber Pl., St. Louis, Mo.
Limbert & Co., Geo. B., 570 Fulton St., Chicago, Ill.
Lincoln Electric Co., 12818 Coit Rd., Cleveland, O.
●Linde Air Products Co., Unit of Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y.
Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.
Liquid Carbonic Corp., 3100 S. Kedzie Ave., Chicago, Ill.
Liquidometer Corp., 36-16 Skillman Ave., Long Island City, N. Y.
Lissberger & Son, Inc., Marks, 23-01 Borden Ave., Long Island City, N. Y.
Little Mfg. Co., M. S., 151 New Park Ave., Hartford, Conn.
Littleford Bros., 421 E. Pearl St., Cincinnati, O.
Locke Regulator Co., 76 North St., Salem, Mass.
Lockport Fittings Co., Inc., Lockport, N. Y.
Logan Engineering Co., 4541 Ravenswood Ave., Chicago, Ill.
Logansport Radiator Equipment Co., Logansport, Ind.
Lonergan Co., J. E., 211 Race St., Philadelphia, Pa.
Lookout Boiler & Mfg. Co., Compress St. & Mfrs. Rd., Chattanooga, Tenn.
Lord Mfg. Co., 1316 Holland St., Erie, Pa.
Lovejoy Tool Wks., 5024 W. Lake St., Chicago, Ill.
Ludcke Corp., 41 N. Beacon St., Watertown, Mass.
Ludlow Valve Mfg. Co., Foot of Adams St., Troy, N. Y.
Ludlum Steel Co., Watervliet, N. Y.
Lukens Steel Co., 104 S. First Ave., Coatesville, Pa.
Lumsden Van Stone Co., 426 First St., South Boston, Mass.
Lunkenheimer Co., Waverly & Beekman Sts., Cincinnati, O.
Luzerne Rubber Co., Muirhead Ave., Trenton, N. J.
Lynchburg Foundry Co., Peoples Bank Bldg., Lynchburg, Va.
Lyon, Conklin & Co., Inc., McComas & Race Sts., Baltimore, Md.
Lytton Mfg. Corp., 102 First Ave., Franklin, Va.

M

Magirl Foundry & Furnace Wks., P. H., 413 E. Oakland Ave., Bloomington, Ill.
Maid-O-Mist, Inc., 180 W. Wacker Dr., Chicago, Ill.
Malleable Iron Fittings Co., Branford, Conn.
Mallory Sales Co., 13904 Lincoln Ave., Dolton, Ill.
Manhattan Rubber Mfg., Div. of Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N. J.
Manitowoc Boiler Wks., 16th & The River, Manitowoc, Wis.
Manley Products Corp., State & Hay Sts., York, Pa.
Manufacturers Machine Co., Railroad Ave., North Andover, Mass.
Maple Valley Mfg. Co., First St., Mapleton, Ia.
Marathon Electric Mfg. Corp., Plumer's Island, P. O. 440, Wausau, Wis.
Marathon Oil Co., Tulsa, Okla.
Marble-Card Electric Co., Gladstone, Mich.
Marion Machine Foundry & Supply Co., P. O. Box 685, 3rd and Big Four Ry., Marion, Ind.
Mark & Co., Clayton 20 N. Wacker Drive, Chicago, Ill.
●Marley Co., 1915 Walnut St., Kansas City, Mo.
Marlo Coil Co., 6135 Manchester Ave., St. Louis, Mo.
Marsh Corp., Jas. P., 2073 Southport Ave., Chicago, Ill.
Marsh Tritrol Co., 720 N. Michigan Ave., Chicago, Ill.
Marsh Valve Co., 4th St. & Brigham Rd., Dunkirk, N. Y.
Marshalltown Mfg. Co., 901 E. Nevada, Marshalltown, Ia.
Martin & Sons, H. P., 801 W. 12th St., Owensboro, Ky.
Martin-Parry Corp., W. Market St., York, Pa.
Martocello & Co., Jos. A., 229 N. 13th St., Philadelphia, Pa.
Masonite Corp., 111 W. Washington St., Chicago, Ill.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Master Electric Co., 100 Davis Ave., Dayton, O.
Master Welders, 2524 Holmes St., Kansas City, Mo.
Matthiesen & Hegeler Zinc Co., 9th & Sterling Sts., La Salle, Ill.
Maurath, Inc., 7309 Union Ave., Cleveland, O.
Maxim Silencer Co., 410 Asylum St., Hartford, Conn.
Maxweld Corp., 140 13th St., Brooklyn, N. Y.
Mayson Mfg. Co., Inc., 4332 Horatio St., Detroit, Mich.
McAlear Mfg. Co., 1901-1909 S. Western Ave., Chicago, Ill.
McAuley Automatic Trap Co., Imperial Power Bldg., Pittsburgh, Pa.
McClave-Brooks Co., Poplar & Park Sts., Scranton, Pa.
McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich.
McCorkle Co., D. H., 6th & Bancroft Way, Berkeley, Cal.
McCormick & Co., J. H., Foot of Susquehanna St., Williamsport, Pa.
McDonnell & Miller, 400 N. Michigan Ave., Chicago, Ill.
McGowan Co., John H., 54-58 Central Ave., Cincinnati, O.
●McQuay, Inc., 1600 Broadway, N. E., Minneapolis, Minn.
McWane Cast Iron Pipe Co., 1201 Vanderbilt Rd., Birmingham, Ala.
●Mears-Kane-Ofeldt, Inc., 1903-1915 E. Hagert St., Philadelphia, Pa.
Mechanical Air, 801 Thomas St., Little Rock, Ark.
Medart Co., 3500 DeKalb, St. Louis, Mo.
Meier Electric & Machine Co., 3525 E. Washington St., Indianapolis, Ind.
Merchant & Evans Co., 2035 Washington Ave., Philadelphia, Pa.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Merco-Nordstrom Valve Co., 400 N. Lexington Ave., Pittsburgh, Pa.
Merrell Mfg. Co., 644 Curtis St., Toledo, O.
Metalace Corp., 60 K St., South Boston, Mass.
Metallo Gasket Co., 16 Bethany St., New Brunswick, N. J.
Metals Coating Co. of America, 495 N. 3rd St., Philadelphia, Pa.
Metropolitan Refining Co., Inc., 23-28 50th Ave., Long Island City, N. Y.
Mettler Co., Lee B., 406 S. Main St., Los Angeles, Cal.
Meyer & Bro. Co., F., 1313 S. Adams St., Peoria, Ill.
Michigan Pipe Co., 503 Phoenix Bldg., Bay City, Mich.
Micro-Westco, Inc., Bettendorf Office Bldg., Bettendorf, Ia.
Mid-Continent Petroleum Corp., Tulsa, Okla.
●Midwest Piping & Supply Co., 1450 Second St., St. Louis, Mo.
Milburn Co., Alexander, 1420 W. Baltimore St., Baltimore, Md.
Miller & Connell Co., 1454-56 N. Claremont Ave., Chicago, Ill.
Miller Conditionair Co., 1138 S. Broadway, Los Angeles, Cal.
Miller Electric Mfg. Co., 905 N. Meade St., Appleton, Wis.
Miller Rubber Co., Inc., 1247 S. High St., Akron, O.
Millers Falls Co., 57 Wells St., Greenfield, Mass.
●Mills Novelty Co., 4110 W. Fullerton Ave., Chicago, Ill.
Milwaukee Reliance Boiler Wks., 2784 N. 32nd St., Milwaukee, Wis.
Milwaukee Valve Co., Chase & Burrell Sts., Milwaukee, Wis.
Mineral Felt Co., 2288 Albion St., Toledo, O.
Mineral Insulation Co., 103rd & Southwest Highway, Chicago Ridge, Ill.
●Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., South, Minneapolis, Minn.
Mitchell Moulding Co., 1501-15 Circle Ave., Forest Park, Ill.
Modine Mfg. Co., 17th St., Racine, Wis.
Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.
Moeller Instrument Co., 132nd St. & 89th Ave., Richmond Hill., N. Y.
Molby Boiler Co., 420 Lexington Ave., New York, N. Y.
Molock Foundry & Machine Co., Kaukauna, Wis.
●Monarch Mfg. Works, Inc., Salmon & Westmoreland Sts., Philadelphia, Pa.
Monarch Metal Weatherstrip Co., 6333 Etzel Ave., St. Louis, Mo.
Monash-Younker Co., 1315 W. Congress St., Chicago, Ill.
Moncrief Furnace Co., P. O. Box 1673, Atlanta, Ga.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Monmouth Products Co., 221 E. 131st St., Cleveland, O.
Montag Stove & Furnace Wks., 2011 N. Columbia Blvd., Portland, Ore.
Montgomery Bros., 61 Fremont St., San Francisco, Cal.
Moore Steam Turbine Corp., Wellsville, N. Y.
Moran Flexible Steam Joint Co., 217 W. Main St., Louisville, Ky.
Morehead Mfg. Co., 4895 Grand River Ave., Detroit, Mich.
Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Cal.
Morris Machine Wks., 20 E. Genesee St., Baldwinsville, N. Y.
Morse Chain Co., Turner Pl., Ithaca, N. Y.
Mortell Co., J. W., 310 S. Michigan Ave., Chicago, Ill.
●Mueller Brass Co., Lapeer Ave., Port Huron, Mich.
Mueller Co., Decatur, Ill.
Mueller Furnace Co., L. J., 2005 W. Oklahoma Ave., Milwaukee, Wis.
Mueller Steam Specialty Co., Inc., 351 W. 26th St., New York, N. Y.
Mullins Mfg. Corp., 1021 Mill St., Salem, O.
Multi-Seal Mfg. Co., 123 N. Jefferson St., Chicago, Ill.
Muncie Gear Wks., Inc., Muncie, Ind.
●Mundet Cork Corp., 450 7th Ave., New York, N. Y.
Murdock Mfg. & Supply Co., 426-30 Plum St., Cincinnati, O.
Murray Iron Wks. Co., 1106 Washington St., Burlington, Ia.
Myers & Bro. Co., F. E., Ashland, O.
Myers Electric Co., 424 Fourth Ave., Pittsburgh, Pa.

N

●Nash Engineering Co., South Norwalk, Conn.
Nash Refrigeration Co., Inc., Summit, New and Bleeker Sts., Newark, N. J.

National Airoil Burner Co., Inc., 1327 Girard Ave., Philadelphia, Pa.
National Boiler Improvement Co., 4100 Georgia Ave., Washington, D. C.
●National Fan & Blower Corp., 543 W. Washington St., Chicago, Ill.
National Gypsum Co., Delaware Ave., Buffalo, N. Y.
National Laboratories, Inc., 501 Statler Bldg., Boston, Mass.
National Lead Co., 111 Broadway, New York, N. Y.
National Machine Wks., Peoples Gas Bldg., Chicago, Ill.
National Metal Products Corp., 21 N. Sheldon St., Chicago, Ill.
National Meter Co., 4221 First Ave., Brooklyn, N. Y.
National Pipe Bending Co., 122 River St., New Haven, Conn.
National Radiator Corp., 221 Central Ave., Johnstown, Pa.
National Regulator Co., 2301 N. Knox Ave., Chicago, Ill.
National Steam Pump Co., 701 W. Johnson St., Upper Sandusky, O.
National Steel Corp., Grant Bldg., Pittsburgh, Pa.
●National Tube Co., 1802 Frick Bldg., Pittsburgh, Pa.
National Valve & Mfg. Co., 3101 Liberty Ave., Pittsburgh, Pa.
National Wood Products Co., 340 Railway St., Hughesville, Pa.
Naugatuck Mfg. Co., 445 N. Main St., Naugatuck, Conn.
Naylor Pipe Co., 1230 E. 92nd St., Chicago, Ill.
Neemes Foundry, Inc., 216 First St., Troy, N. Y.
Nelson Corp., Herman, 1824 Third Ave., Moline, Ill.
Neptune Meter Co., 50 W. 50th St., New York, N. Y.
●Nesbitt, Inc., John J., & Buckeye Blower Co.,, State Rd. & Rhawn St., Philadelphia, Pa.
New Albany Machine Mfg. Co., E. 10th & Water Sts., New Albany, Ind.
New Departure Div., General Motors Corp., Bristol, Conn.
New Haven Copper Co., Seymour, Conn.
New Jersey Zinc Sales Co., Front & Fletcher Sts., New York, N. Y.
Newman Brothers, Inc., 666 W. Fourth St., Cincinnati, O.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
New York Air Valve Corp., 476 Broome St., New York, N. Y.
New York Blower Co., 3155 Shields Ave., Chicago, Ill.
New York Brass Foundry, 405 Broome St., New York, N. Y.
Niagara Blower Co., 6 E. 45th St., New York, N. Y.
Niagara Machine & Tool Wks., 637-697 Northland Ave., Buffalo, N. Y.
Nicholson & Co., W. H., 12 Oregon St., Wilkes-Barre, Pa.
Niles Rolling Mill Co., Niles, O.
Norge Heating & Conditioning Div., Borg-Warner Corp., 670 E. Woodbridge St., Detroit, Mich.
Norgren Co., Inc., C. A., Denver, Colo.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Norristown Magnesia & Asbestos Co., Washington St., Norristown, Pa.
North American Mfg. Co., 2910 E. 75th, Cleveland, O.
Northern Blower Co., 6409 Barberton Ave., Cleveland, O.
Northern Indiana Brass Co., 935 Plum St., Elkhart, Ind.
Northern Weatherstrip Co., 367 S. First Ave., E., Duluth, Minn.
Northwestern Chemical Co., 104 State St., Marietta, O.
Norwalk Co., Inc., Water St., S. Norwalk, Conn.
Norwood Engineering Co., Florence, Mass.
Nugent Sons, Inc. Thos., 223 E. 80th St., New York, N. Y.
Nu-Way Corp., 2416-4th Ave., Rock Island, Ill.
Nye Tool & Machine Wks., 4120-30 Fullerton Ave., Chicago Ill.

O

Oberdorfer Brass Co., M. L., 2307 Thompson Rd., Syracuse, N. Y.
Ohio Brass Co., N. Main St., Mansfield, O.
Ohio Electric Mfg. Co., 5906 Maurice Ave., Cleveland, O.
Ohio Injector Co., Wadsworth, O.
Ohio Pattern Works & Foundry Co., Eureka Valve Div., 2735 Colerain Ave., Cincinnati, O.
Ohio Pipe Bending & Machine Co., 3900-3910 Trent Ave., Cleveland, O.
Ohio Products Co., 17606 Milburn Ave., Cleveland, O.
Ohio Valley Pulley Wks., Div. Browning Mfg. Co., Inc., Maysville, Ky.
Ohl & Son, George A., 159 Graton St., Newark, N. J.
Oil Well Supply Co., Oil City, Pa.
Orr & Sembower, Inc., Box 817, Reading, Pa.
●Oster Mfg. Co., 2057 E. 61st Pl., Cleveland, O.
Otis Steel Co., 3341 Jennings Rd., Cleveland, O.
Owen-Dyneto Corp., Syracuse, N. Y.
●Owens-Illinois Glass Co., Ohio Bldg., Toledo, O.

P

Pacific Lumber Co., 102 Bush St., San Francisco, Cal.
Pacific Steel Boiler Div., United States Radiator Corp., 1056 First National Bank Bldg., Detroit, Mich.
Page Steel & Wire, Div. of American Chain Co., Inc., Monessen, Pa.
Paine Co., 2951 W. Carroll Ave., Chicago, Ill.
Palmer Co., 267 Clay St., Cincinnati (St. Bernard), O.
Palmer Electric Co., 1258 Park Pl., Detroit, Mich.
"Pamco" Conditionaire Co., 4223 W. Lake St., Chicago, Ill.
Pangborn Corp., Panborn Blvd., Hagerstown, Md.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Paragon Kol-Master Corp., Oregon, Ill.
Parker Appliance Co., 17325 Euclid Ave., Cleveland, O.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Parks-Cramer Co., 970 Main St., Fitchburg, Mass.
Patterson Foundry & Machine Co., East Liverpool, O.
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.
Patterson Shade Co., 1525 N. Meridian St., Indianapolis, Ind.
Payne Furnace & Supply Co., 336-338 N. Foothill Rd., Beverly Hills, Cal.
Peabody Engineering Corp., 580 Fifth Ave., New York, N. Y.
Peck, Stow & Wilcox Co., Center St., Southington, Conn.
Peerles Electric Co., 1401 W. Market St., Warren, O.
Peerless Heater Co., Boyertown, Pa.
Peerless Ice Machine Co., 515 W. 35th St., Chicago, Ill.
Peerless Machine Co., 1615 Racine St., Racine, Wis.
Peerless Unit Ventilation Co., Inc., 810 Union Ave., Bridgeport, Conn.
Pels & Co., Inc., Henry, 90 West St., New York, N. Y.
Penberthy Injector Co., 1242 Holden Ave., Detroit, Mich.
Penn Cooling Tower Wks., 1337 Nixon St., Pittsburgh, Pa.
Penn Electric Switch Co., 2000 E. Walnut, Des Moines, Ia.
Penn Mfg. Corp., of Washington, Pa., 380 W. Chestnut St., P. O. Box 484, Washington, Pa.
Pennsylvania Engineering Wks., 526 S. Jefferson St., New Castle, Pa.
Pennsylvania Forge Co., Milnor & Bleigh Sts., Philadelphia, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Perfection Grate & Stoker Co., 4 Fisk Ave., Springfield, Mass.
Perfection Refrigeration Parts Co., Harvey, Ill.
Perfex Controls Co., 415 W. Oklahoma Pl., Milwaukee, Wis.
Perfex Radiator Co., 415 W. Oklahoma Pl., Milwaukee, Wis.
Perkins & Son, Inc., B. F., Chicopee St., Holyoke, Mass.
Permutit Co., 330 W. 42nd St., New York, N. Y.
Peterson Freezen Mfg. Co., 109 W. 18th St., Kansas City, Mo.
Petroleum Heat & Power Co., 110 Davenport St., Stamford, Conn.
Petrometer Corp., 1 Star Sq., Long Island City, N. Y.
Pfaudler Co., 89 East Ave., Rochester, N. Y.
Phelps Dodge Corp., British American Tube Div., 40 Wall St., New York, N. Y.
Philadelphia Gear Co., Erie Ave. & G St., Philadelphia, Pa.
Philadelphia Pipe Bending Co., 4135-65 N. Fifth St., Philadelphia, Pa.
Philadelphia Thermometer Co., 915 Filbert St., Philadelphia, Pa.
Phoenix Brass Fittings Corp., Coit St. & Chancellor Ave., Irvington, N. J.
Phoenix Ice Machine Co., 2711 Church St., Cleveland, O.
Pierce Butler Radiator Corp., 701 Nichols Ave., Syracuse, N. Y.
Pioneer Heat Regulator Corp., 100 Davis Ave., Dayton, O.
Pioneer Roofing & Sheet Metal Co., 226 N. Main St., Muskogee, Okla.
Pittsburgh Brass Mfg. Co., 3155 Penn Ave., Pittsburgh, Pa.
Pittsburgh Equitable Meter Co., 400 N. Lexington Ave., Pittsburgh, Pa.
Pittsburg Lectrodryer Corp., P. O. Box 1008, Pittsburgh, Pa.
Pittsburgh Pipe Coil & Bending Co., 59 Bridge St., Etna, Pa.
●Pittsburgh Piping & Equipment Co., 43rd St. & A. V. R. R., Pittsburgh, Pa.
Pittsburgh Steel Co., Union Trust Bldg., Pittsburgh, Pa.
Pittsburgh Tube Co., Vandergrift Bldg., Pittsburgh, Pa.
Pittsburgh Valve & Fittings Corp., Barberton, O.
Pittsburgh Valve Foundry & Construction Co., 26th St. & Allegheny Valley R. R., Pittsburgh, Pa.
Pittsburgh Water Heater Co., Box 1109, Pittsburgh, Pa.
Plummer Spray Equipment Co., 700 Filmore St., Napoleon, O.
Plymouth Cordage Co., Court St., N. Plymouth, Mass.
●Pomona Pump Co., 206 E. Commercial St., Pomona, Cal.; 53 W. Jackson Blvd., Chicago, Ill.
Poole Foundry & Machine Co., 3730 Clipper Mill Rd., Woodberry, Baltimore, Md.
●Porter & Co., Inc., H. W., 825 Frelinghuysen Ave., Newark, N. J.
Powell Co., Wm., 2525 Spring Grove Ave., Cincinnati, O.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
●Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill.
●Practical Instrument Co., 2717 N. Ashland Ave., Chicago, Ill.
Presstite Engineering Co., 3900 Chauteau St., St. Louis, Mo.
Pressure Oil Burners, Inc., 55 N. Broad St., York, Pa.
Propellair, Inc., 1345 Lagonda Ave., Springfield, O.
Prox Co., Frank, 1201 S. First St., Terre Haute, Ind.
Public Works Supply Co., 93 Brookline St., Lynn, Mass.
Pure Carbonic, Inc., Lincoln Bldg., New York, N. Y.
Pyott Foundry & Machine Co., 328 N. Sangamon St., Chicago, Ill.
Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.

Q

Quaker City Iron Wks., Tioga & Richmond Sts., Philadelphia, Pa.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.

R

Radiator Specialty Co., Charlotte, N. C.
●Radiostat, Inc., 1227 W. Washington Blvd., Chicago, Ill.

Rafter Machine Co., 259 Stephens St., Belleville, N. J.
Raisler Sprinkler Co., 129 Amsterdam Ave., New York, N. Y.
Ramsay Chain Co., Inc., 1029 Broadway, Albany, N. Y.
●Randall Graphite Products Corp., 609 W. Lake St., Chicago, Ill.
Ravena Iron Co., Ravena, N. Y.
Rawlplug Co., Inc., 98 Lafayette St., New York, N. Y.
Ray Oil Burner Co., 401-499 Bernal Ave., San Francisco, Cal.
Raymond Co., F. I., 629 Washington Blvd., Chicago, Ill.
Reading Iron Co., 401 N. Broad St., Philadelphia, Pa.
●Reading-Pratt & Cady Co., Inc., 929 Connecticut Ave., Bridgeport, Conn.
Red Jacket Pump Co., Davenport, Ia.
Redi Automatic Coal Burners, Inc., N. 107 Freyar St., Spokane, Wash.
Reed Steam Equipment Co., 136 Fairfield Ave., Bridgeport, Conn.
Reed Unit-Fans, Inc., 730-34 St. Charles St., New Orleans, La.
Refinite Co., Refinite Bldg., Omaha, Neb.
Refractory & Insulation Corp., 381 Fourth Ave., New York, N. Y.
●Refrigeration Appliances, Inc., 1342 W. Lake St., Chicago, Ill.
Rega Mfg. Co., 79 Mt. Hope Ave., Rochester, N. Y.
Register & Grille Mfg. Co., Inc., 70 Berry St., Brooklyn, N. Y.
Reichert Float & Mfg. Co., 2238 Smead Ave., Toledo, O.
Reif-Rexoil, Inc., 37-41 Carroll St., Buffalo, N. Y.
Reliance Electric & Engineering Co., Ivanhoe Rd., Cleveland, O.
Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, O.
Reliance Refrigerating Machine Co., 3401 N. Kedzie Ave., Chicago, Ill.
●Rempe Coil Co., 340 N. Sacramento Blvd., Chicago, Ill.
Rensaeller Valve Co., Ontario St., Cohoes, N. Y.
Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.
Republic Rubber Co., Youngstown, O.
● Republic Steel Corp., Republic Bldg., Cleveland, O.
Research Corp., Chrysler Bldg., New York, N. Y.
Resisto Pipe & Valve Co., 262 Bridge St., East Cambridge, Mass.
●Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Revolving Doors, Inc., 542 W. 27th, New York, N. Y.
Reynolds Corp., 19 Rector St., New York, N. Y.
Reznor Mfg. Co., Mercer, Pa.
●Rhoads & Sons, J. E., 11th & B. & O. R. R., Wilmington, Del.
Rhode Island Fitings Co., Hillsgrove, R. I.
Rhode Island Humidifier & Ventilating Co., 99 Chauncy St., Boston, Mass.
Rhodes, Inc., M. H., 2000 RKO Bldg., New York, N. Y.
Richardson & Boyton Co., 244 Madison Ave., New York, N. Y.
Richmond Radiator Co., Inc., Uniontown, Pa.
●Ric-wiL Co., 1562 Union Trust Bldg., Cleveland, Co.
●Ridge Tool Co., Box 670, Elyria, O.
Riley Stoker Corp., 9 Neponset St., Worcester, Mass.
Ripley Co., W. R., 318 N. E St., Tacoma, Wash.
Riverside Boiler Wks., Inc., 50 Harvard St., Cambridge, Mass.
Robbins & Myers, Inc., Lagonda Ave., Springfield, O.
Roberts-Gordon Appliance Corp., 137 Arthur St., Buffalo, N. Y.
Robertson Co., H. H., 2000 Grant Bldg., Pittsburgh, Pa.
Rochester Mfg. Co., Inc., Rockwood St., Rochester, N. Y.
Rock Island Register Co., 2435 Fifth Ave., Rock Island, Ill.
Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis, Ind.
Rockwood Sprinkler Co. of Mass., 38 Harlow St., Worcester, Mass.
Rock Wool Products Co., P. O. Box 276, Wabash, Ind.
Roebling's Sons, John A., South Broad St., Trenton, N. J.
Roessing Mfg. Co., 1616 Noble St., Sharpsburg Sta., Pittsburgh, Pa.
Roller Bearing Co. of America, Whitehead Rd., Trenton, N. J.
Rome-Turney Radiator Co., Canal St., Rome, N. Y.
Roots-Connersville Blower Corp., 16th St. & Columbia Ave., Connersville, Ind.
Roper Corp., Geo. D., Blackhawk Ave., Rockford, Ill.
Rosedale Foundry & Machine Co., Columbus & Preble Aves., N. S., Pittsburgh, Pa.
Ross Engineering Corp., J. O., 350 Madison Ave., New York, N. Y.
Ross Heater & Mfg. Co., Inc., 1407 West Ave., Buffalo, N. Y.
Ross Sprinkler Co., 34 Roberts St., Pasadena, Cal.
Rotary Mfg. Co., 5718 Long Beach Ave., Los Angeles, Cal.
Rotary Seal Co., 809 W. Madison St., Chicago, Ill.
Royal Ventilator Co., 415 Locust St., Philadelphia, Pa.
Royersford Foundry & Machine Co., Inc., Royersford, Pa.
R-S Products Corp., Germantown Ave., at Wayne Junction, Philadelphia, Pa.
Ruberoid Co., 500 Fifth Ave., New York, N. Y.
Ruby Chemical Co., 74 McDowell St., Columbus, O.
Ruggles-Klingemann Mfg. Co., 4 Foster Ct., Salem, Mass.
Rumsey Pump Corp., Seneca Falls, N. Y.
Russell & Co., W. A., Rm. 1734, Grand Central Terminal Bldg., New York, N. Y.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Russell Electric Co., 348 W. Huron St., Chicago, Ill.
Ruud Mfg. Co., 2934 Smallman St., Pittsburgh, Pa.
R. U. V. Engineering Corp., 110 E. 42nd St., New York, N. Y.

S

St. Louis Blow Pipe & Heater Co., 1954 N. 9th St., St. Louis, Mo.
Sales & Co., Murray W., 801 W. Baltimore Ave., Detroit, Mich.
Sall Mountain Co., 176 W. Adams St., Chicago, Ill.
Sampsel Stoker Corp., Mendota, Ill.
Sangamo Electric Co., 1301 N. 11th St., Springfield, Ill.
●Sarco Co., Inc., 183 Madison Ave., New York, N. Y.
Sauereisen Cements Co., 2308 Main St., Sharpsburg, Pa.
Saunders Sons, Inc., D., 25 Atherton St., Yonkers, N. Y.
Savage Arms Corp., 100 E. 42nd St., New York, N. Y.
Scaife & Sons Co., Wm. B., 26 Ann St., Oakmont, Pa.
Schade Valve Mfg. Co., 2527 N. Bodine St., Philadelphia, Pa.
Schaphorst, W. F., 45 Academy St., Newark, N. J.
Schatz Mfg. Co., Fairview, Poughkeepsie, N. Y.
Schatz Venetian Blinds, Los Angeles, Cal.
Schaub Engineering Co., Fred H., 325 W. Huron St., Chicago, Ill.
Schneible Co., Claude B., 4755 N. Pulaski, Chicago, Ill.
Schoedinger, F. O., 322-358 Mt. Vernon Ave., Columbus, O.
Schramm, Inc., West Chester, Pa.
Schubert-Christy Corp., Box 166, Affton Station, St. Louis, Mo.
Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa.
Schwitzer-Cummins Co., 1125 Massachusetts Ave., Indianapolis, Ind.
Scientific Instrument Co., 531-35 W. Larned, Detroit, Mich.
Scott-Newcomb, Inc., 1922 Pine St., St. Louis, Mo.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Scovill Mfg. Co., 99 Mill Street, Waterbury, Conn.
Seamlex Co., 5-19 48th Ave., Long Island City, N. Y.
Self-Vulcanizing Rubber Co., Inc., 605 W. Washington Blvd., Chicago, Ill.
Semans & Sons, Geo. G., 416 Lyceum Bldg., Pittsburgh, Pa.
Semet-Solvay Engineering Corp., 40 Rector St., New York, N. Y.
Semler Co., Jeannette, Pa.
Seneca Wire & Mfg. Co., Fostoria, O.
●Servel, Inc., 119 Morton Ave., Evansville, Ind.
Shafer Bearing Corp., 35 E. Wacker Dr., Chicago, Ill.
Shallcross Controls, Inc., 121 N. Broadway, Milwaukee, Wis.
Shank, Cyrus, 625 W. Jackson Blvd., Chicago, Ill.
Sharon Steel Corp., Sharon, Pa.
Shaw Co., Benjamin F., Second & Lombard Sts., Wilmington, Del.
Shaw-Kendall Engineering Co., 120-130 S. Superior St., Toledo, O.
Shaw-Perkins Mfg. Co., Oliver Bldg., Pittsburgh, Pa.
Sheer Co., H. M., Second & Hampshire Sts., Quincy, Ill.
Sight Feed Generator Co., 14-18 N. 10th St., Richmond, Ind.
Silent Glow Oil Burner Corp., 1477 Park St., Hartford, Conn.
Simplex Heating Specialty Co., Inc., Peoples Bank Bldg., Lynchburg, Va.
Simplex Oil Heating Corp., 30 Church St., New York, N. Y.
Sims Co., 18th & Whitley Sts., Erie, Pa.
Sinclair Refining Co., 45 Nassau, New York, N. Y.
Sinker-Davis Co., 230 S. Missouri St., Indianapolis, Ind.
SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.
Skidmore Corp., St. Joseph, Mich.
Skilsaw, Inc., 3310 N. Elston Ave., Chicago, Ill.
Skinner Co., M. B., South Bend, Ind.
Skinner Engine Co., 337 W. 12th St., Erie, Pa.
Skinner Irrigation Co., 1212 E. Canal St., Troy, O.
Slater Mfg. Co., 24 Water St., Wakefield, Mass.
Sly Mfg. Co., W. W., 4700 Train Ave., Cleveland, O.
Smidth & Co., F. L., 225 Broadway, New York, N. Y.
Smith Co., H. B., 57 Main, Westfield, Mass.
Smith Heater Co., Peter, 6209 Hamilton St., Detroit, Mich.
Smith, Inc., James Campbell, 16374 Euclid Ave., Cleveland, O.
Smith, Inc., Winfield H., Eaton St., Springville, N. Y.
Smith & Kanzler, Inc., 516-534 Lidgerwood Ave., Elizabeth, N. J.
Smith Twin Tubular Boiler Co., Inc., Cottman St. at State Rd., Philadelphia, Pa.
Smith Welding Equipment Co., 2633 S. E. Fourth St., Minneapolis, Minn.
Smolensky Valve Co., Inc., 1931 W. 47th St., Cleveland, O.
Smooth-On Mfg. Co., 568-574 Communipaw Ave., Jersey City, N. J.
Somers, Inc., H. J., 6063 Wabash Ave., Detroit, Mich.
Somerville Iron Wks., Somerville, N. J.
South Chester Tube Co., Front & Thurlow Sts., Chester, Pa.
Southworth Machine Co., 30 Warren Ave., Portland, Me.
Spang, Chalfant & Co., Inc., Clark Bldg., Pittsburgh, Pa.
Spear Stove & Heating Co., James, 1823 Market St., Philadelphia, Pa.
Speedway Mfg. Co., 1834 S. 52nd Ave., Chicago (Cicero), Ill.
Spence Engineering Co., Inc., 32 Grant St., Walden, N. Y.
Spencer Heater Co., 652 Oliver St., Williamsport, Pa.
Spencer Thermonstat Co., 34 Forest St., Attleboro, Mass.
Spencer Turbine Co., 486 New Park Ave., Hartford, Conn.
Spray Engineering Co., 114 Central St., Somerville, Mass.
Sprayo-Flake Co., 56 S. Bay St., Milwaukee, Wis.
Spoehrer-Lange Co., 3723 Commonwealth St., St. Louis, Mo.
Sprout-Waldron & Co., Muncy, Pa.
Square D Co., 6060 Rivard St., Detroit, Mich.

Squires Co., C. E., E. 4th St. & Keeley Ave., Cleveland, O.
Standard Air Conditioning, Inc., 40 W. 40th St., New York, N. Y.
Standard Asbestos Mfg. Co., 820-822 W. Lake St., Chicago, Ill.
Standard Auto-Tite Joint Co., 7501 Thomas Blvd., Pittsburgh, Pa.
Standard Engineering Wks., 289 Roosevelt Ave., Pawtucket, R. I.
Standard Galvanizing Co., 2611-2619 W. Van Buren St., Chicago, Ill.
Standard Lime and Stone Co., 2004 First National Bank Bldg., Baltimore, Md.
Standard Oil Co., of California, 225 Bush, San Francisco, Cal.
Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, Ill.
Standard Thermometer, Inc., 65 Shirley St., Boston, Mass.
Standard Union Co., 71 Gooding St., Lockport, N. Y.
Stanley Wks., 195 Lake St., New Britain, Conn.
Staples & Pfeiffer, Ltd., 528 Bryant St., San Francisco, Cal.
Star Brass Mfg. Co., 108 E. Dedham St., Boston, Mass.
Star Electric Motor Co., 197 Grove St., Bloomfield, N. J.
Star Expansion Bolt Co., 147 Cedar St., New York, N. Y.
Star Mfg. Co., Inc., 530 Kinsley Ave., Providence, R. I.
Star Products Co., 554 E. 141st St., New York, N. Y.
Star Radiator Co., 649 Ceres Ave., Los Angeles, Cal.
Starbuck & Sons, Inc., R. M., P. O. Box 1331, Hartford, Conn.
Starr Piano Co., Richmond, Ind.
•Staynew Filter Corp., 25 Leighton Ave., Rochester, N. Y.
Stay-Rite Co., Inc., 1250 W. Fourth St., Cleveland, O.
Steel Improvement & Forge Co., 960 Addison Rd., Clevland, O.
Steel Products Engineering Co., Columbia St. & Dakota Ave., Springfield, O.
Steel and Tubes, Inc., 224 E. 131st St., Cleveland, O.
Steelweld Machinery Co., E. 70th & Machinery Ave., Cleveland, O.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles, Cal.
Sterling Engineering Co., 3738 N. Holton St., Milwaukee, Wis.
Sterling Engineering & Mfg. Corp., 117 Business St., Hyde Park, Mass.
Stevens-Root Co., 51 E. Grand Ave., Chicago, Ill.
Stickle Steam Specialties Co., 2215 Valley Ave., Indianapolis, Ind.
Stilphen Engineering & Mfg. Co., C. A., 1129 18th St., Denver, Col.
Stockham Pipe & Fittings Co., 4100 Tenth Ave., N., Birmingham, Ala.
Stokermatic Co., 1415 S. State St., Salt Lake City, Utah.
Stokers, Inc., 10821 E. Jefferson St., Detroit, Mich.
Stokes Rubber Co., Jos., Taylor & Webster, Trenton, N. J.
Stone, Junius H., 1265 Broadway, New York, N. Y.
Strandwitz & Co., Inc., 537 S. 2nd St., Camden, N. J.
•Streamline Pipe & Fitings Div., Mueller Brass Co., Lapeer Ave., Port Huron, Mich.
Strong, Carlisle & Hammond Co., 1394 W. Third St., Cleveland, O.
Strong-Scott Mfg. Co., Taft & Kennedy Sts., N. E., Minneapolis, Minn.
Struthers-Wells-Titusville Co., Warren, Pa.
•Sturtevant Co., B. F., Damon St., Hyde Park, Boston, Mass.
Sundstrand Machine Tool Co., 2531 11th St., Rockford, Ill.
Superior Sheet Steel Co., Division of Continental Steel Corp., Canton-Louisville Rd., Canton, O.
Super Radiator Corp., 320 Plymouth Bldg., Minneapolis, Minn.
Superstat Co., 38 Walter St., Springfield, Mass.
Supreme Electric Products Corp., 99 Mt. Hope Ave., Rochester, N. Y.
Supreme Heater & Ventilating Corp., 1915 Pine St., St. Louis, Mo.
Surface Combustion Corp., 2375 Dorr St., Toledo, O.
Swaby Mfg. Co., 2010 Marshall Blvd., Chicago, Ill.
Swartwout Co., 18511 Euclid Ave., Cleveland, O.
Swedish Venetian Blind Co., 601 W. 26th St., New York, N. Y.
Syncromatic Air Conditioning Corp., 3373 N. Holton St., Milwaukee, Wis.

T

Taber Pump Co., 272 Elm St., Buffalo, N. Y.
Taco Heaters, Inc., 342 Madison Ave., Brooklyn, N. Y.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Tatro Bros, Inc., 218 Washington St., Decorah, Ia.
Taylor Engineering Co., Metropole Hotel, Cincinnati, O.
Taylor Forge & Pipe Wks., P. O. Box 485, Chicago, Ill.
•Taylor Instrument Companies, 95 Ames St., Richester, N. Y.
Tennessee Coal, Iron & Railroad Co., Brown-Marx Bldg., Birmingham, Ala.
Terry Steam Turbine Co., 874 Windsor Ave., Hartford, Conn.
Texas Co., 135 E. 42nd St., New York, N. Y.
Thatcher Co., 39 St. Francis St., Newark, N. J.
Thermal Units Mfg. Co., 64 E. 25th St., Chicago, Ill.
Thermax Div., Northwest Magnesite Co., Farmers Bank Bldg., Pittsburgh, Pa.
Therminsul Corp., 1603 Fulford St., Kalamazoo, Mich.
Thermoid Rubber Co., Whitehead Rd., Trenton, N. J.
Thrush & Co., H. A., Peru, Ind.
Thwing-Albert Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa.
Tierney Rotor Ventilator Co., 239 Fourth Ave., S. Minneapolis, Minn.
•Timken Steel & Tube Co., Canton, O.
Timken Roller Bearing Co., 1835 Dueber Ave., S. W. Canton, O.
Tippett & Wood, Taylor & Wilson Sts., Phillipsburg, N. J.
Titusville Iron Wks. Co., S. Franklin St., Titusville, Pa.
Todd Combustion Equipment, Inc., Foot 23rd St., Brooklyn, N. Y.
Toledo Pipe Threading Machine Co., 1445 Summit St., Toledo, O.
Torchweld Equipment Co., 1025 W. Lake St., Chicago, Ill.
Tork Clock Co. Inc., 33 South St., Mt. Vernon, N. Y.
Torrey Refrigeration Products, 1000 N. Orange Dr., Los Angeles, Cal.
•Torrington Mfg. Co., 70 Franklin St., Torrington, Conn.
Trageser Steam Copper Wks., John, 5000 Grand St., Maspeth, Long Island, N Y.
•Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., 626 Brunswick Ave., Trenton, N. J.
Trerice Co., H. O., 1420 W. Lafayette Blvd., Detroit, Mich.
•Trimont Mfg. Co., 55-71 Amory St., Roxbury, Boston, Mass.
Trimount Rotary Power Co., 398 Whiting Ave., East Dedham, Mass.
Triox Engineering Co., 207 Board of Education Bldg., St. Louis, Mo.
Triplex Mfg. Co., Peru, Ind.
Triumph Ice Machine Co., 107-109 E. Front St., Cincinnati, O.
Troy Engine & Machine Co., Troy, Pa.
Trumbull Electric Mfg. Co., Woodford Ave., Plainville, Conn.
Truscon Steel Co., 1315 Albert St., Youngstown, O.
Tryco Products, Inc., Railroad Sq., Westfield, Mass.
•Tube-Turns, Inc., 425 S. Fifth St., Louisville, Ky.
Turner Brass Wks., 823-47 Park Ave., Sycamore, Ill.
Tuthill Pump Co., 131 W. 63rd St., Chicago, Ill.
•Tuttle & Bailey, Inc., Corbin Ave., New Britain, Conn.
XXth Century Heating and Ventilating Co., Cor. Ira & Edison Aves., Akron, O.

U

Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.
Una Welding, Inc., 1615 Collamer Ave., E., Cleveland, O.
Underground Steam Construction Co., 73 Pitts St., Boston, Mass.
Unified Air Conditioner Co., 322 W. Michigan St., Duluth, Minn.
Uniflow Mfg. Co., E. Lake Rd., Erie, Pa.
•Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y.
Union Fibre Co., Winona, Minn.
Union Iron Wks., 1500 Cascade St., Erie, Pa.
Union Metal Wks., Inc., 80 Carter St., Chelsea, Mass.
Union Steam Pump Co., Jefferson Ave., Battle Creek, Mich.
Union Water Meter Co., 333 Hermon St., Worcester, Mass.
United American Bosch Corp., 3664 Main St., Springfield, Mass.
United Cork Companies, Central Ave., Kearney, N. J.
United Electric Controls Co., 69 A St., Boston, Mass.
United States Brass & Copper Co., Hyde Park, Boston, Mass.
United States Gauge Co., 44 Beaver St., New York, N. Y.
United States Gypsum Co., 300 W. Adams St., Chicago, Ill.
United States Ozone Co. of America, Crescent St., Scottdale, Pa.
United States Pipe & Foundry Co., Burlington, N. J.
United States Radiator Corp., 1056 National Bank Bldg., Detroit, Mich.
United States Register Co., Burnham St., Battle Creek, Mich.
United States Rubber Products, Inc., 1790 Broadway, New York, N. Y.
•United States Steel Corp., Pittsburgh, Pa.
United Superior Union Co., Inc., 29 Ryerson St., Brooklyn, N. Y.
•Unit Heater & Cooler Co., 1002-1024 Third St., Wausau, Wis.
Universal Air Filter Corp., Duluth, Minn.
Universal Cooler Corp., Green & Melville Aves., Detroit, Mich.
Universal Gypsum & Lime Co., 105 W. Madison St., Chicago, Ill.
Universal Motor Co., 323 Universal Ave., Oshkosh, Wis.
Universal Power Corp., 4300 Euclid Ave., Cleveland, O.
Uno Ventilator Co., 339 Lincoln Ave., Cliftondale, Mass.
Upson Quality Products Co., Upson Point, Lockport, N. Y.
U. S. Air Conditioning Corp., 2101 Kennedy St., N. E., Minneapolis, Minn.
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Cal.
U. S. Electrical Tool Co., 2488-2496 W. 6th St., Cincinnati, O.
U. S. Expansion Bolt Corp., Holland Plaza Bldg., 75 Varick St., New York, N. Y.
U. S. Hame Co., 135 Tonawanda St., Buffalo, N. Y.
U. S. Mineral Wool Co., 280 Madison Ave., New York, N. Y.
U. S. Motors Corp., Oshkosh, Wis.
U. S. Pipe Bending Co., 840 Harrison St., San Francisco, Cal.
U. S. Pressed Steel Products Co., Kalamazoo, Mich.
U. S. Stoneware Co., 60 E. 42nd St., New York, N. Y.
Utica Products, Inc., 1101 Burrstone Rd., Utica, N. Y.
Utica Radiator Corp., 2201 Dwyer Ave., Utica, N. Y.

Utility Fan & Mfg. Co., 2528 Santa Fe Ave., Los Angeles, Cal.

V

Vallen, Inc., 225 Bluff, Akron, O.
Vanderman Mfg. Co., Mansfield Ave., Willimantic, Conn.
Vapor Heating Co., 101 W. 42nd St., New York, N. Y.
Van Kannel Revolving Door Co., 101 Park Ave., New York, N. Y.
Ventilating Products Co., 2800 Cottage Grove Ave., Chicago, Ill.
Vento Steel Sash Co., Muskegon, Mich.
Vibration Eliminator Co., 4126-37th St., Long Island City, N. Y.
Victaulic Co. of America, 26 Broadway, New York, N. Y.
Victor Equipment Co., Kimball-Krogh Pump Div., 1010 E. 62nd St., Los Angeles, Cal.
Viking Air Conditioning Corp., Main & Center Sts., N. W., Cleveland, O.
Viking Pump Co., Fourth and State Sts., Cedar Falls, Ia.
Viking Shear Co., Pittsburg Ave., Erie, Pa.
●Vilter Mfg. Co., 2148 S. First St., Milwaukee, Wis.
Vinco Co., Inc., 305 E. 45th St., New York, N. Y.
Virginia Smelting Co., West Norfolk, Va.
Vitreous Enameling & Stamping Co., 1381 Sedgwick Ave., New York, N. Y.
Vogt Machine Co., Henry, 10th & Ormsby Sts., Louisville, Ky.
Voss, Inc., J. H. H., 408 Concord St., New York, N. Y.
Vulcan Arc Welder Mfg. Co., 2636 Olive St., St. Louis, Mo.
Vulcan Radiator Co., 73 Homestead Ave., Hartford, Conn.

W

●Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Waldron Corp., John, New Brunswick, N. J.
Wallace Supplies Mfg. Co., 1310 Diversey Pkwy., Chicago, Ill.
Walsh-Holyoke Steam Boiler Co., Holyoke, Mass.
Walsh-Spencer Co., 400 Boylston St., Boston, Mass.
●Walworth Co., 60 E. 42nd St., New York, N. Y.
Ward Foundry, Inc., J. P., Blossburgh, Pa.
Ward Leonard Electric Co., 37 South St., Mt. Vernon, N. Y.
Warren Electric Appliance Company, Warren Bank & Trust Co. Bldg., Warren, Pa.
Warren Foundry & Pipe Corp., 11 Broadway, New York, N. Y.
Warren Shade Co., Inc., 2905 E. Hennepin Ave., Minneapolis. Minn.
Warren Steam Pump Co., Inc., Warren, Mass.
Washburne & Co., E. G., 207 Fulton St., New York, N. Y.
Water Cooling Tower Co., 4530 Drexel Blvd., Chicago, Ill.
Waterfilm Boilers, Inc., 154 Ogden Ave., Jersey City, N. J.
●Waterloo Register Co., 2520 E. 4th St., Waterloo, Ia.
Watson & McDaniel Co., 440 N. Marshall, Philadelphia, Pa.
●Watson-Stillman Co., 140 Aldene Rd., Roselle, N. J.
Watts Regulator Co., 250 Lowell St., Lawrence, Mass.
Waukesha Motor Co., Waukesha, Wis.
Way Panel Loctor Co., Wollaston, Mass.
Wayne Oil Burner Corp., 800 Glasgow Ave., Fort Wayne, Ind.
Weatherhead Co., 620 Frankfort St., Cleveland, O.
●Webster & Co., Warren, 17th & Federal Sts., Camden, N. J.
Webster Electric Co., Clark & DeKoven Aves., Racine, Wis.
Wedge Protectors, Inc., 9522 Richmond Ave., Cleveland, O.
Weil-McLain Co., 641 W. Lake St., Chicago, Ill.
Weil Pump Co., 215-17 W. Superior St., Chicago, Ill.
Weinman Pump Co., 290 Spruce St., Columbus, O.
Weirton Steel Co., Weirton, W. Va.
Western Blower Co., 1800 Airport Way, Seattle, Wash.
Western Felt Wks., 4029-4117 Ogden Ave., Chicago, Ill.
Western Furnaces, Inc., 3002 S. Chandler, Tacoma, Wash.
Western Hanger Co., 55 New Montgomery St., San Francisco, Cal.
Western Rotary Ventilator Co., Inc., 1720 E. 14th St., Los Angeles, Cal.
Western Venetian Blind Co., 601 W. 26th St., New York, N. Y.
Western Wire Products Co., 1415-35 S. 18th St., St. Louis, Mo.
●Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
●Westinghouse Electric & Mfg. Co., Mansfield, O.
Weston Electrical Instrument Corp., 619 Frelinghuysen Ave., Newark, N. J.
Wheatland Tube Co., 606-608 Real Estate Trust Bldg., Philadelphia, Pa.
Wheeler Mfg. Co., C. H., 19th, Lehigh & Sedgley Aves., Philadelphia, Pa.
●Wheeling Steel Corp., Wheeling Steel Corp. Bldg., Wheeling, W. Va.
White Co., Kelvin & Wilfred B., 90 State St., Boston, Mass.
White Mfg. Co., 2362 University Ave., St. Paul, Minn.
Whiting Corp., Harvey, Ill.
Whitlock Coil Pipe Co., 100 South St., Hartford, Conn.
Whitney Mfg. Co., Bartholomew Ave., Hartford, Conn.
Whitney Mfg. Co., W. A., 636 Race St., Rockford, Ill.
Whitney Metal Tool Co., 110 Forbes St., Rockford, Ill.
Wickes Boiler Co., 502 N. Water St., Saginaw, Mich.
Wickwire Spencer Steel Co., 41 E. 42nd St., New York, N. Y.
Wiedemann Machine Co., 1815 Sedgley Ave., Philadelphia, Pa.
●Wiegand Co., Edwin L., 7610 Thomas Blvd., Pittsburgh, Pa.
Willard Metallic Crypt Co., Willard, O.
Will-Burt Co., Orrville, O.
●Williams & Co., J. H., 75 Spring St., New York, N. Y.
Williams & Son, I. B., Dover, N. H.
Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.
Williams, Inc., F. C., 22805 Michigan Ave., Dearborn, Mich.
Williams Oil-O-Matic Heating Corp., 1201 East Bell, Bloomington, Ill.
Williams Valve Co., D. T., Spring Grove Ave. & Township Street, Cincinnati, O.
Will-Weld Mfg. Co., Inc., 1501 Jackson St., Omaha, Nebr.
Wilson & Co., 4100 S. Ashland Ave., Chicago, Ill.
Wilson Co., H. A., 97 Chestnut St., Newark, N. J.
Wilson Welder & Metals Co., Inc., 956-38th St., North Bergen, N. J.
Winchester Repeating Arms Co., 275 Winchester Ave., New Haven, Conn.
●Wing Mfg. Co., L. J., 14th St. & 7th Ave., New York, N. Y.
Wiss & Sons Co., J., 33 Littleton Ave., Newark, N. J.
Wittenmeier Machinery Co., 850-860 N. Spaulding Ave., Chicago, Ill.
Wolff & Munier, Inc., 222 E. 41st St., New York, N. Y.
Wolverine Tube Co., 1455 Central Ave., Detroit, Mich.
Wood Conversion Co., 1981 First National Bank Bldg., St. Paul, Minn.
Wood Industries, Inc., Gar, 7924 Riopelle St., Detroit, Mich.
Wood's Sons Co., T. B., 1275 Fifth Ave., Chambersburg, Pa.
Worthington-Gamon Meter Co., Harrison, N. J.
●Worthington Pump & Machinery Corp., Harrison, N. J.
Wright-Austin Co., 315 W. Woodbridge St., Detroit, Mich.
Wyckoff & Son Co., A., 100 Home St., Elmira, N. Y.

X

X Laboratories, 25 W. 45th St., New York, N. Y.
X L Refrigerating Co., 1834 W. 59th St., Chicago, Ill.

Y

Yardley Screen & Weather Strip Corp., 142 Parsons Ave., Columbus, O.
●Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia, Pa.
Yates-American Machine Co., Beloit, Wis.
Yeomans Bros. Co., 1433 N. Dayton St., Chicago, Ill.
●York Ice Machinery Corp., Roosevelt Ave., York, Pa.
York Oil Burner Co., Inc., P. R. R. & Jessup Pl., York, Pa.
Yost Mfg. Co., Meadville, Pa.
●Young Radiator Co., 709 Mead St., Racine, Wis.
●Young Regulator Co., Dept. H, 4500 Euclid Ave., Cleveland, O.
Youngstown Pressed Steel Co., Warren, O.
●Youngstown Sheet & Tube Co., 602 Stambaugh Bldg., Youngstown, O.

Z

Zeh & Hahnemann Co., 182-200 Vanderpool St., Newark, N. J.
Zobell Electric Motor Corp., 96 South Ave., Garwood, N. J.
Zonolite Corp., Fisher Bldg., Detroit, Mich.